

NATURAL HISTORY

Bird Collecting in Polynesia

By ROLLO H. BECK

An Unexplored Area of the Southwest

By EARL H. MORRIS

Australia's Wonderful Wild Life

By CHARLES BARRETT

The Department of Mammals, American Museum

By H. E. ANTHONY

Nature Study with the Microscope

By PHILIP O. GRAVELLE

JOURNAL OF THE AMERICAN
MUSEUM OF NATURAL HISTORY

The American Museum of Natural History

BOARD OF TRUSTEES

HENRY FAIRFIELD OSBORN, President
CLEVELAND H. DODGE, First Vice President
J. P. MORGAN, Second Vice President
GEORGE F. BAKER, JR., Treasurer
PERCY R. PYNE, Secretary
GEORGE F. BAKER
FREDERICK F. BREWSTER
THOMAS DEWITT CUYLER
WALTER DOUGLAS
CHILDS FRICK
MADISON GRANT

WILLIAM AVERELL HARRIMAN
ARCHER M. HUNTINGTON
ADRIAN ISELIN
ARTHUR CURTISS JAMES
WALTER B. JAMES
OGDEN MILLS
A. PERRY OSBORN
GEORGE D. PRATT
THEODORE ROOSEVELT
LEONARD C. SANFORD
JOHN B. TREVOR

FELIX M. WARBURG

JOHN F. HYLAN, MAYOR OF THE CITY OF NEW YORK
CHARLES L. CRAIG, COMPTROLLER OF THE CITY OF NEW YORK
FRANCIS D. GALLATIN, COMMISSIONER OF THE DEPARTMENT OF PARKS

GEORGE H. SHERWOOD, Executive Secretary

SCIENTIFIC STAFF

FREDERIC A. LUCAS, Sc.D., Director
ROBERT C. MURPHY, Assistant to the Director (in Scientific Correspondence, Exhibition, and Labeling)
JAMES L. CLARK, Assistant to the Director (in Full Charge of Preparation).

DIVISION OF MINERALOGY AND GEOLOGY

W. D. MATTHEW, F.R.S., Curator-in-Chief
Geology and Invertebrate Palaeontology

EDMUND OTIS HOVEY, Ph.D., Curator
CHESTER A. REEDS, Ph.D., Associate Curator of Invertebrate Palaeontology.

Mineralogy

HERBERT P. WHITLOCK, C.E., Curator
GEORGE F. KUNZ, Ph.D., Research Associate, Gems

Vertebrate Palaeontology

HENRY FAIRFIELD OSBORN, LL.D., D.Sc., Honorary Curator
W. D. MATTHEW, Ph.D., Curator
WALTER GRANGER, Associate Curator of Fossil Mammals
BARNUM BROWN, A.B., Associate Curator of Fossil Reptiles
WILLIAM K. GREGORY, Ph.D., Associate in Paleontology

DIVISION OF ZOOLOGY AND ZOOGEOGRAPHY

FRANK MICHLER CHAPMAN, N.A.S., Curator-in-Chief

Lower Invertebrates

ROY W. MINER, Ph.D., Curator
WILLARD G. VAN NAME, Ph.D., Assistant Curator
FRANK J. MYERS, Research Associate, Rotifera
HORACE W. STUNKARD, Ph.D., Research Associate, Parasitology
A. L. TREADWELL, Ph.D., Research Associate, Annulata

Entomology

FRANK E. LUTZ, Ph.D., Curator
A. J. MUTCHLER, Assistant Curator in Coleoptera
FRANK E. WATSON, B.S., Assistant in Lepidoptera
CHARLES W. LENG, B.S., Research Associate, Coleoptera
HERBERT F. SCHWARZ, A.M., Research Associate, Hymenoptera

WILLIAM M. WHEELER, Ph.D., Research Associate, Social Insects

Ichthyology

BASHFORD DEAN, Ph.D., Honorary Curator
JOHN T. NICHOLS, A.B., Associate Curator of Recent Fishes
E. W. GUDGER, Ph.D., Associate in Ichthyology

Herpetology

G. KINGSLEY NOBLE, Ph.D., Associate Curator (In Charge)
ARTHUR ORTENBURGER, M.S., Assistant Curator

Ornithology

FRANK M. CHAPMAN, Sc.D., Curator
W. DEW. MILLER, Associate Curator
ROBERT CUSHMAN MURPHY, D.Sc., Associate Curator of Marine Birds
JAMES P. CHAPIN, A.M., Assistant Curator, African Birds
LUDLOW GRISCOM, M.A., Assistant Curator
JONATHAN DWIGHT, M.D., Research Associate in North American Ornithology
MRS. ELSIE M. B. REICHENBERGER, Research Assistant

Comparative Anatomy

WILLIAM K. GREGORY, Ph.D., Curator
S. H. CHUBB, Assistant in Osteology
J. HOWARD MCGREGOR, Ph.D., Research Associate in Human Anatomy

Mammalogy

ROY C. ANDREWS, A.M., Associate Curator of Mammals of the Eastern Hemisphere
H. E. ANTHONY, A.M., Associate Curator of Mammals of the Western Hemisphere
HERBERT LANG, Assistant Curator, African Mammals
CARL E. AKELEY, Associate in Mammalogy

DIVISION OF ANTHROPOLOGY

CLARK WISSLER, Ph.D., Curator-in-Chief

Anthropology

CLARK WISSLER, Ph.D., Curator
PLINY E. GODDARD, Ph.D., Curator of Ethnology
N. C. NELSON, M.L., Associate Curator of North American Archaeology
CHARLES W. MEAD, Assistant Curator of Peruvian Archaeology
LOUIS R. SULLIVAN, A.M., Assistant Curator, Physical Anthropology
CLARENCE L. HAY, A.M., Research Associate in Mexican and Central American Archaeology

Comparative Physiology

RALPH W. TOWER, Ph.D., Curator

Comparative Anatomy

WILLIAM K. GREGORY, Ph.D., Curator
J. HOWARD MCGREGOR, Ph.D., Research Associate in Human Anatomy

DIVISION OF EDUCATION, BOOKS, PUBLICATION, AND PRINTING

GEORGE H. SHERWOOD, A.M., Curator-in-Chief

Library and Publications

RALPH W. TOWER, Ph.D., Curator
IDA RICHARDSON HOOD, A.B., Assistant Librarian

Public Education

GEORGE H. SHERWOOD, A.M., Curator
G. CLYDE FISHER, Ph.D., Associate Curator
RUTH CROSBY NOBLE, B.A., Assistant Curator
GRACE FISHER RAMSEY, Assistant Curator

Public Health

CHARLES-EDWARD AMORY WINSLOW, D.P.H., Honorary Curator
MARY GREIG, Assistant

Natural History Magazine

HERBERT F. SCHWARTZ, A.M., Editor

ADVISORY COMMITTEE

GEORGE H. SHERWOOD A.M., (Ex officio)
FRANK M. CHAPMAN, Sc.D., Curator-in-Chief, Division of Zoology and Zoogeography
W. D. MATTHEW, Ph.D., Curator-in-Chief, Division of Mineralogy and Geology
CLARK WISSLER, Ph.D., Curator-in-Chief, Division of Anthropology

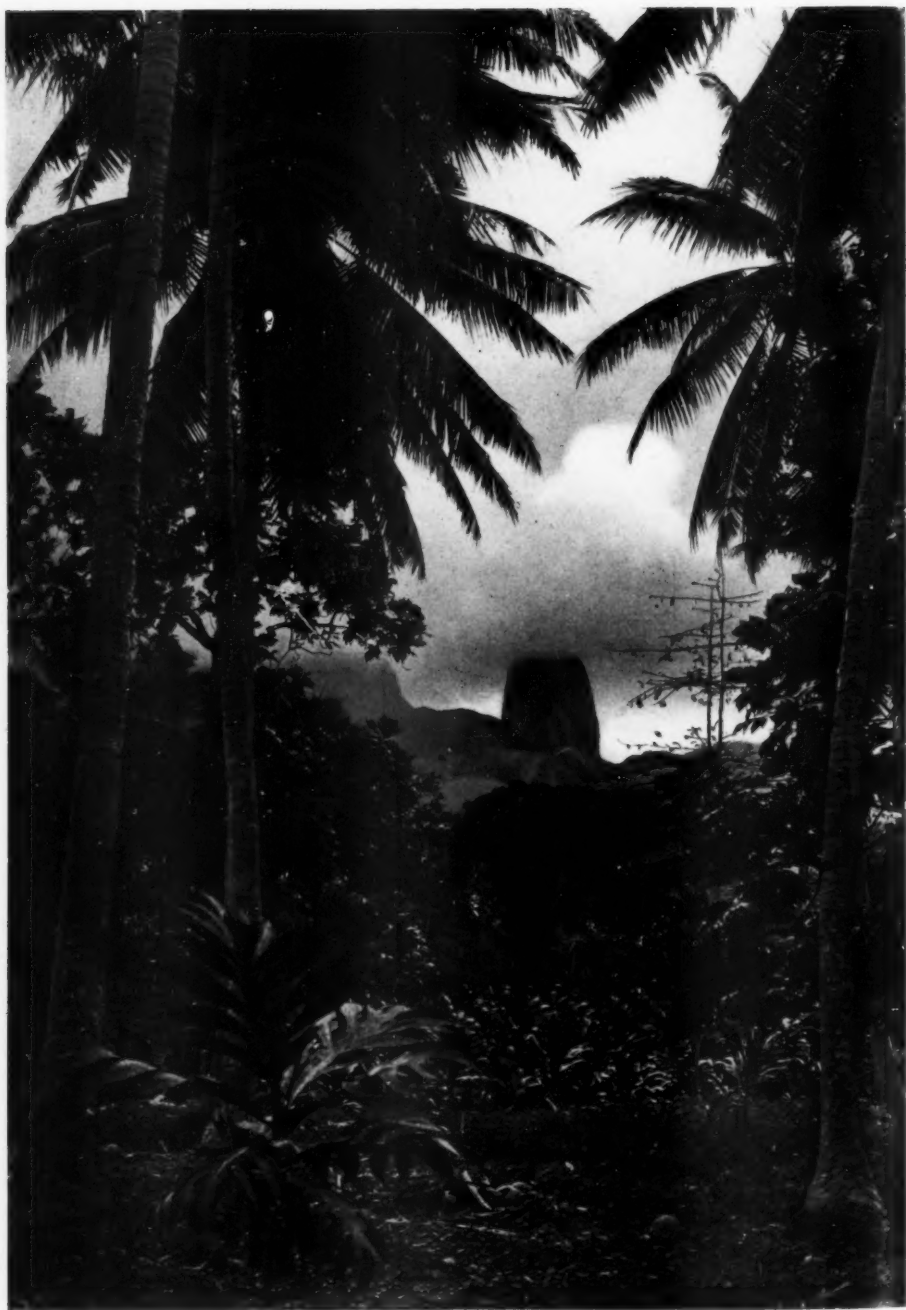
of
of

un
p-
al
un

in
N,

ry

of
of
of



LOOKING WESTWARD AT ONE OF THE PEAKS ON HUAPU ISLAND

A beautiful little parakeet (*Coriphilus smaragdinus*) is found only in Huapu. It was there, too, that the leader of the Whitney Expedition observed a lone specimen of the sanderling (*Crocelhia alba*)—a North American shore bird for which he had been on the lookout ever since his arrival in the South Pacific

NATURAL HISTORY

VOLUME XXII

NOVEMBER-DECEMBER, 1922

NUMBER 6

BIRD COLLECTING IN POLYNESIA

EXPERIENCES OF THE WHITNEY SOUTH SEA EXPEDITION AMONG THE
TUAMOTU AND MARQUESAS ISLANDS

BY

ROLLO H. BECK*

WE HAD been voyaging for several days in the schooner "Hinano" among the Tuamotu Islands, a low-lying group of the South Pacific, named not inappropriately by the early navigators the "Dangerous Archipelago." At Niau, the first of our stops, I had secured specimens of three land birds—a warbler (*Conopoderas sp.*) a kingfisher (*Sauropatis sp.*), and a dove (*Ptilopus coralensis*)—different in some respects from the related species of Tahiti. In Fakarawa Island, where the governor of the thousand-mile stretch of Tuamotu Islands lives, the only land birds seen were warblers, although several terns and a white reef heron (*Demigretta sacra*) were noted along the lagoon shore.

On our way from Fakarawa to Takaroa we sailed at the sunset hour for several miles along the low, barren reef of broken coral that characterizes the south-east side of Aratika Island, thus obtaining a close-up view of a typical atoll. At places the rock was covered with a few inches of water and on one slight elevation where a single coconut tree and a few low bushes offered shelter, a flock of large, dark-brown boobies (*Sula leucogaster plotus*) were settling for the night. A mile farther along the coast, three coconut trees and their surrounding bushes served as a place of refuge for a flock of noddy terns (*Anous stolidus*) while above soared several frigate birds

(*Fregata minor palmerstoni*) which were also getting ready to settle for the night. A reef heron flew along and alighted on the outer edge of the reef, perhaps to watch for small fish that the shallow water protected from larger enemies, and a wandering tattler (*Heteractitis incanus*) winged its way above the surface of the water seeking a place shallow enough to come to rest but, finding none, was forced to continue inland before alighting.

Takaroa, our next place of sojourn, has been occupied for more than twenty-five years by a Mormon mission, and the church, with its pretentious cupola, is the most conspicuous building on the island and the only one that was left by the hurricane of 1906, the ravages of which are still traceable.

After leaving this port we sailed down the coast a few miles before bringing the "Hinano" to a stop. A boat was then sent ashore for the purpose of obtaining a load of firewood and coconuts. The engineer, his wife, and I utilized this opportunity to step on shore. As we neared the landing it was interesting to watch the numerous sizable fish that were washed up with every incoming swell and that were permitted to swim a few yards before being swept back again into the deep water beyond the precipitous wall of coral that opposes the agitated blue sea. The engineer, armed with a five-pronged spear, jumped out of the boat

*Leader of the Whitney South Sea Expedition.

before we were fairly on the reef and had plunged the weapon into a ten-pound fish while we were still engaged in pulling the boat slowly shoreward through the shallow water. In the course of an hour his sugar sack was half full of fish, most of them weighing a pound and a half, but some a great deal heavier.

From a distance I saw his wife wielding the spear and heard her squealing with

We returned to the "Hinano" with our varied load and after beating to windward for eight days, we reached Nukuhiva Island, a member of the Marquesan group, about four hundred miles to the northeast.

The dry-looking vegetation on the west side of the island gave place to bright green as we neared the rainy quarter on the south, and as we ap-



A tiny cove on the lagoon shore of Takaroa Island, showing low growths with coconut trees towering over them. Beautiful indeed are these graceful trees as they breast the breeze that bends back their fronds. But the havoc wrought by storms is sometimes great. The ravages of the hurricane of 1906 are still traceable in parts of Takaroa

laughter as she ran splashing after a school of fishes twelve inches long which had been headed off from the edge of the reef and were swimming erratically back and forth with their dorsal fins out of water and a curling wake to show where they had just been. The greater number went through the water so much faster than the laughing girl that they had but little difficulty in evading her casts, but she managed to capture a couple before the main part of the school had reached safety in the deep water.

proached our anchorage, several heavy showers came sweeping up from the southeast, penetrating the narrow bays and dropping their waters on the luxuriant growth that covered that portion of the mountainous shore line.

We cast anchor a short distance off the beach and glancing shoreward I distinguished the figures of Doctor Brown and his wife, botanists from the Bishop Museum of Honolulu, standing on the porch of a modern-looking cottage, which had served them as a base for

several months' work in the islands. Going ashore, we were able to make good our promise of the previous spring, to visit them in their Marquesan laboratory. In a large case on the wall and on the tables were piled hundreds of papers containing botanical specimens, and in one corner of the commodious room were dozens of small vials and larger bottles filled with seeds and fruits of the island plants. In the bushes and trees outside the house warblers (*Conopodera* sp.) were pouring forth their melodies, while along the roadway a couple of the island swifts flew back and forth, picking out of the air their evening meal of mosquitos.

Mrs. Beck accepted the invitation to remain ashore, but I was compelled to return aboard to make ready for an early start on the morrow, as I wanted to do some collecting before we set sail the next evening for Hivaoa Island. It was there that the government administrator of the Marquesas, who had accompanied us from Papeete, had his residence. The administration headquarters had formerly been at Nukuhiva, but the presence of hosts of nonos, a mean midget fly the bites of which raise welts far larger than those produced by the mosquito, prompted the officials to transfer their offices to Hivaoa, an island lying to the southeast, where they would be exposed merely to the milder torment of the mosquitos.

Going ashore at daylight, I followed a steep trail that led across the mountains to Taipe¹ Bay, the scene of Melville's tale of Marquesan life in the nineteenth century. Ripe, juicy mangoes were lying in the trail under a spreading tree; bananas were abundant on the cañon sides close to the stream; and breadfruit trees were seen in every yard as well as in the forest that fringed the trail. The houses that I passed were mostly frame buildings with galvanized iron roofs and several had troughs to carry the

rain water to barrels at the corners of the buildings.

As on the previous day, heavy rains fell at frequent intervals and I was soaked to the skin when I returned after lunch bringing with me a few warblers and a swift (*Collocalia thespesia*) that I had bagged during the morning. The large pigeon (*Serresius galeatus*) of Nukuhiva lives only on the dry western side of the island and does not occur on any of the other islands of the Marquesan group; the white-crowned dove (*Ptilopus dupe-titthouarsii*), on the other hand, is common on all of the larger islands.

We left in the evening for Hivaoa and, after a stormy passage of three days, covered the sixty miles of water that intervened, entering the Bay of Traitors at midnight. Bright and early next morning the administrator was set ashore at the picturesque landing place. It was here that later in the day I saw a sailor tumble into the swirling water while trying to pass a box—part of some Chinese baggage—to another sailor, stationed in an unsteady boat that was bobbing back and forth against the face of the rocks. The sailor in the boat concerned himself with the recovery of the box, which was floating about in the water, while his drenched companion grasped the gunwale, pulled himself on to the rocks again, and resumed the passing of the baggage into the boat with no further thought of his involuntary ducking.

At four in the afternoon we got under way again for Huapu Island, which lies to the west of Hivaoa, and arriving there at an early hour in the afternoon of the following day, I had an opportunity to go ashore with my camera while the supercargo made inquiries about copra. As we rode in to the beach on the crest of a swell, a small bird rose from the sandy shore and I recognized it at once as a sanderling (*Crocethia alba*)—a North American shore bird that I had been looking for ever since our arrival in the South Pacific. A week later I secured a

¹Typee is the spelling used by Melville and is the title of his book.



HIVA OA

Three days were consumed in fighting the mountainous seas between Nukuhiva Island and Hivaoa,—a welcome place of refuge for the storm-tossed travelers



HATIHEU BAY, NUKUHIVA ISLAND

These splintered peaks, with jagged summits silhouetted against the sky, hold the vision as one glances westward along the beach at the head of Hatiheu Bay



GATHERING COPRA ON THE NORTH SHORE OF HATHEU BAY
Copra—the dried meat of the coconut—is an important article of export from not a few of the Polynesian Islands



SCENE ON THE NORTH SIDE OF NUKUHIVA

The picture shows a little settlement at the head of one of the numerous bays that indent the shores of this island



This old stone wall on Huapu Island is a relic of a former generation. The forest growth soon encroaches on these masses of masonry, and sizeable trees, like the papaya here shown, raise themselves in token of conquest above the works of man



Some of the old foundations built by former generations of Marquesans still serve the present generation

specimen on Nukuhiva, this being the fifth species that I felt sure had come all the way from Alaska to visit this region and thus avoid the northern winter.

In a wide-mouthed valley there were a few houses encompassed by numerous breadfruit trees and coconut trees, and everywhere about this settlement grew wild cotton plants, indicating that while the Civil War was raging in the United States, cotton growing may have been a thriving industry at Huapu as in many other South Sea Islands.

At the upper end of this little community was a small Catholic church where a few of the inhabitants had gathered for the afternoon service; the greater number, however, had seated themselves in front of their houses or along the lane, to inspect us and give the Marquesan greeting, which sounded more like "co-ow" than anything else. As I neared the church the congregation was dispersing. One old man among the worshippers attracted my gaze, for he was heavily tattooed across the face. Next day I discovered this man busily engaged in making bowls of the tamanu wood, but when I asked him for carved bowls, he told me that only one man on the island did carving and that he lived in another valley, so I did not get a chance to obtain one of the rare pieces of artistic Marquesan handicraft.

The supercargo, having located a few tons of copra, decided to linger in port an additional day. Accordingly at day-break on the following morning I again went on shore and made my way up a well-traveled trail toward the interior and to valleys farther up the coast. Family groups of warblers were flying from weeds and bushes into the guava trees, which bore ripening fruit. I had walked less than a mile when I saw the first parrakeet (*Coriphilus smaragdinus*) a beautiful little bird that is found only on this island, resembling in its restricted habitat the red-crowned dove, which is confined to Hivaoa, and the big blue-backed pigeon, which is peculiar to

Nukuhiva. During the day I saw a number of the little pehites, as the parrakeets are called locally, and watched with great interest their aerial evolutions, in which they vied with their neighbors, the sea-going fairy terns, circling in the fresh wind over the mountain ridges and flying upward in wide circles until they had reached an altitude high enough to enable them to clear the peaks in their sweeps from one cañon to another. It was usually single birds that disported themselves in this way. Companies of four or five individuals, on the other hand, kept close to the forest trees, finding their food amid the ripening berries or else in the blossoming flowers that gave color to the cañon sides.

In the bottom of one cañon, where flowed a small stream, I met a native carrying a bunch of bananas, who pleasantly said "co-ow" as I passed. Four hours later on my return, I was surprised to find him only a few feet away from the same spot, though he had in the meantime picked another small bunch of bananas, and his wife, who was with him, had gathered a bunch of green leaves to be used in wrapping up poi-poi on the morrow. When I stopped a short distance up the trail to listen to a bird's song, the couple passed me on their homeward way, the woman carrying the two bunches of bananas on a pole, while the man, smoking his pipe, tramped on ahead with the bundle of green leaves under his arm.

At one place in the thick forest I came across several of the old stone platforms on which former generations of Marquesans had built their homes, and in tramping around in other islands of the group, I frequently saw similar building sites or old stone fences that in the course of time had been covered with forest growth.

When I returned at four o'clock, the last load of copra was going aboard and shortly afterward we sailed for Nukuhiva again, to take on additional cargo. Reaching the cliff-bound southern coast at nine o'clock on a rainy night, the cap-

tain mistook the entrance to his bay and sailed five miles to the westward of it before discovering the mistake. Putting out to sea again with furled sails, he employed the motor to work up along the dangerous coast to the proper anchorage.

Next morning I carried my birds ashore and skinned them on the porch of Doctor Brown's house. The chief impression I have of the next two days is

huts erected on similar bases. It was, however, on the north side of the island, which we reached next day, that the best examples of the old rockwork were found. One of the sites visited had been used for religious purposes, and the carefully laid stonework extended for a hundred yards in one direction and for many yards in the other. Scattered around this structure were a number of well-



Making poipoi, a dish relished in Polynesia

that of warding off nonos, which in spite of all my vigorous fanning inflicted many painful bites.

Sailing again at midnight, we entered Taïpe Bay soon after sun-up, where the crew spent the day getting copra from the warehouse on the beach. Poles had been erected to hold the drying coconuts, and in addition defoliated trees were used for this purpose.

Several of the frame houses of this settlement were built on top of the ancient rock foundations used by the old-time Marquesans, and up the cañon a mile or more I found a couple of native

built *paepae* on which had stood the dwellings of former generations of the fast-vanishing race.

On one of the piles of built-up bowlders had been erected a modern-looking house. In front of it was a platform for drying copra, and just before the door of the house a young man was diligently pounding a mass of poipoi made from taro roots. At his side was a huge bowl of brownish-colored poipoi made from the fermented breadfruit, which, before being used, had been allowed to lie in a hole underground for the usual number of months. I sampled both lots. Al-

though the poi-poi made from the taro roots was not unpleasant in taste, the peculiar flavor of the other stayed with me for a long time. Near the breadfruit groves I saw several pits filled with this fruit over which in turn had been placed a covering of leaves, and on top of the leaves a pile of rocks.

From the village on the north side of the island a trail led back over the ridge into the head of the Taïpe Valley on the south. I climbed up two thousand feet or so and looked across the rugged Taïpe Cañon to a beautiful waterfall directly opposite the pass through which the trail led. The higher parts of the island seemed one succession of sharp ridges and narrow cañons, heavily forested and wrapped in clouds most of the time; as I looked back into the valley from which I had just climbed, the thousands of coconut trees around the head of the bay, with the dark upright masses of rocks on the west side, formed a picture that made me regret that I did not have a larger camera with which to register the beauty of the scene, my small pocket camera being inadequate for the purpose.

We spent three days in this locality, visiting a different bay each day and getting a few tons of copra from the shores of each. Working in the small warehouses, our crew filled sack after sack. Whenever a half dozen sacks were ready, the supercargo weighed them, using for the purpose a steelyard tied to a stick. The pole from which the apparatus was suspended was carried during the operation of weighing upon the shoulders of a couple of stalwart sailors.

On the shores of one of these bays I sat down under a forest tree to eat my lunch, but I found the nonos and mosquitos so ravenous that it was necessary for me to wave a small branch about my head continuously; however, when I was walking, they did not bother me. Wild chickens, pigs, and goats were abundant in this part of the island, and the engineer shot some chickens and goats, the pigs evading him.

Sooty terns (*Sterna fuliginosa*), which one sees almost daily in small numbers at sea when within three hundred miles of land, nest on many of the outlying islets that are striking features of the coast lines of the Marquesas, and when we sailed close by such an islet, a blast of the ship's siren would send a cloud of terns circling into the air. There are several of these bird rocks around Nukuhiva and some of them furnish the natives with a good many eggs and young birds during the nesting season.

When we left Nukuhiva, a course was set for Huahuna Island forty miles to the eastward. Here we entered a bay so narrow that there was barely room to turn the schooner. After the forward anchor and the kedge anchor astern had been lowered, a couple of lines were made fast to the rocks on one side of the cove and, though the captain found only three fathoms of water under the stern when he dropped the lead over, we remained safely at our moorings for a day, thanks to these precautions, getting a little copra, three horses, some pigs, sheep, and chickens.

Perhaps the most perfect example of tattooing—a practice formerly common but eschewed by the rising generation—was seen at this place. One old man, clad in a pareu, had his entire body covered with the artistic designs that will soon be seen no more on living flesh. To get a picture of him I had to bribe him with a present of five francs, but the resulting photograph did not show the intricate markings of the needle. Another old man had a strip of tattooing across his face, and I had seen an old woman at Hivaoa whose legs were well marked with the blue ink of the tattooer. As the custom of tattooing ceased about thirty years ago, it will soon be necessary to refer to anthropological books for a record of the designs used.

The horses of this island were notably better looking than those seen elsewhere, and the cowboy saddle of the western United States seemed to be in greater

favor than any other style. Attached to one house was a pen in which were a dozen goats and a couple of cows; pigs were running unrestrained about the village and back and forth up the cañon; half a dozen saddled horses were standing in the stony lane that served as the main street.

I had only four hours ashore Monday morning in which to collect. I found the flycatchers (*Pomarea nigra*), which were commoner on this island than on any other previously visited, ranging over the hillsides and on the ridges in a manner quite different from that of the birds of Hivaoa, Huapu, or Tahiti, which keep to the dense thickets in the bottoms of cañons. As we hoisted anchor, I saw a flock of seven curlews (*Numenius tahitiensis*)—something I had not witnessed since visiting Christmas Island a few hundred miles to the northward.¹

Due to favorable weather conditions we reached Hivaoa the next morning at about nine and spent the remainder of the day ashore. I was out on deck at daylight as we approached the island, and the first birds I noted were a fairy tern (*Leucanous microrhynchus*) and a red-footed booby (*Sula piscator*), early precursors of birds to be seen later in the day. The spirelike peaks of Huapu Island to the northward jutted into the clouds, and the high central ridge on Hivaoa was overhung by a heavy fog.

As we neared the southeastern end of the island, birds appeared in greater numbers, the sooty terns flying higher than their congeners, the noddies. A white-breasted, black-necked plotus booby contrasted strongly with his grayish plumaged relatives of the red feet; five miles from land a flock of lesser noddies, duplicates in color of their larger kin, were seen hovering over a school of fish. High above them sailed the black-robed frigate bird, watching with eager eye for some tern or booby to capture a

fish, whereupon this pirate of the air would swoop down to harry the captor until the latter unwillingly disgorged what it had won through its efforts. As we sailed along the southern shore, fairy terns, frequently in pairs, flew about, coming from all quarters and some of them heading landward to feed their young, which were secreted in *Pandanus* trees high up on the mountain-side. Running closely along the shore to avoid the strong wind and current, we sighted a dozen wild goats, startled by the hallooing of the crew, who stood at the rail and lined the bowsprit as we rounded Point Teahoa and brought into view the custom house on the beach at Atuona. Soon we were anchored in a small harbor, a mile from the settlement. Here hundreds of coconut trees covered the hillsides and stretched away into the valley to the northward, through which flows a fine stream of fresh water.

A day's walk up the valley is an interesting event, as I discovered when I made the trip. After leaving the beach, the trail passes for more than a mile through a coconut grove and at one place on the route are mango and coffee trees, as well as a grove of bananas, all bearing at this time their various products. Farther up the narrowing cañon, after the stream forked, I entered a vanilla plantation. The thick vines, bushes, and tangle of trees had been cleared from the rocky bed and small posts had been erected, up which the vanilla plants had climbed with astonishing rapidity. As there are no native insects that fertilize the flowers of the vanilla plant, the owner of the plantation has to go through it every day in the flowering season and with a small pointed stick take a little pollen from the upper part of the flower and introduce it into a tiny cup of the same flower lower down. One might think this a laborious task, but an expert can apply the pollen in a second or two and only a limited number of the flowers on a plant are treated.

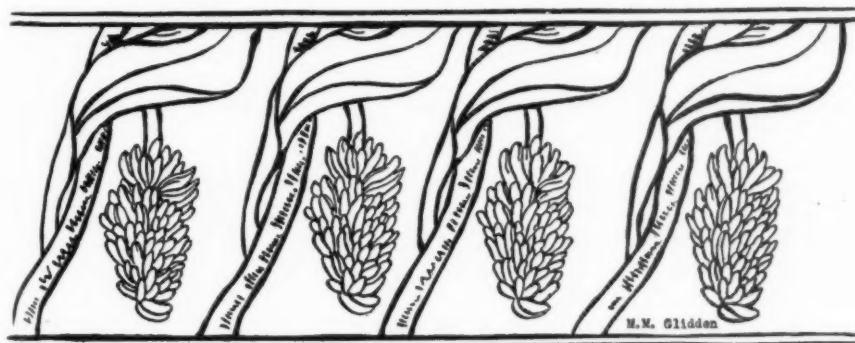
Beyond the vanilla plantation a little

¹For an account of Mr. Beck's visit to Christmas Island, the reader is referred to NATURAL HISTORY, July-August, 1921, pp. 398-407.

used trail was followed, past old stone fences and tumbling rock piles till the cañon narrowed to the width of the running water. At one place on the boulder-strewn cañon side was a little rock-encircled pit in which breadfruit had formerly been buried, to be resurrected later and eaten. On the cliffs high above me, noddy and fairy terns sailed around and around, and a pair of tropic birds (*Phaethon lepturus*) joined them for a few moments while I watched. Doves were cooing, and persistent calling on my part would usually bring one or more of the small flycatchers to chitter-chatter over my head in the buro trees. Orange and lemon trees with juicy fruit growing on the higher branches, as well as guava trees, which here in the cañon reached a

height exceeding thirty feet, drew my attention more than once. I was interested to note later that growing on the plateau were other guava trees, which although only three feet in height, were already bearing fruit. Our time at Hivaoa was too short to enable me to cover the island properly, but I spent another day on the plateau, where, at the highest point visited, I found the beautifully colored, red-crowned doves (*Ptilopus tristrami*), and I returned at dark with specimens of this little-known species.

Our stay in the Marquesas was all too short to make more than a preliminary survey, but long enough to show us what was needed and what to do on a subsequent voyage.





A DESCENT INTO NAVAJO CAÑON

A trail in this region may be compared to a sinuous thread running from water hole to water hole, and strange may be the course it follows. Here the knife-like crest of a sand dune, two hundred fifty feet in height beneath the horsemen in the foreground, offered a means of descent from the rim of the cañon to the pool where the vanguard of the pack train may be seen between the two clumps of trees at the left center

AN UNEXPLORED AREA OF THE SOUTHWEST*

BY

EARL H. MORRIS

ALONG the boundary line between Arizona and Utah, within the mighty northward curving bow formed by the Colorado River and its largest eastern tributary, the San Juan, there lies a country of unusual charm to the lover of nature and to the archæologist. The region is a vast plateau furrowed by hundreds of miles of labyrinthian cañons at every turn of which the traveler may expect new and pleasing vistas to unfold before his eyes and will seldom be disappointed. The magnificent desolation which is the dominant tone of the scenery weaves round the wayfarer an enchantment which ever calls him back to tread again the old trails and make conquest of the new.

The spell fell heavily upon Mr. Charles L. Bernheimer, whose initial visit to the Rainbow Natural Bridge, the most striking geologic phenomenon of the region, was described in a previous number of *NATURAL HISTORY*. As a result Mr. Bernheimer organized a more extensive expedition for the summer of 1921, of which it was the writer's good fortune to be a member.

We left Flagstaff, Arizona, on the afternoon of June 26. The road led northward through a pine-clad valley among the San Francisco Peaks and thence down a long, gentle declivity to Tanner's Crossing on the Little Colorado. In front and to the right of us lay the edge of the Painted Desert, its basic shades of red and green merging so softly with the mellower tints that one could scarcely determine where earth left off and sky began. Beyond the river, which at this season was a bed of sand between vertical walls of stone, the road again led northward, now over a ragged, barren upland of variegated shales and sandstone, and down to the crossing of the Moencopi

Wash, where the fields and orchards surrounding the westernmost village of the Hopi made a pleasing picture in their frame of mottled cliffs.

From the rim of the Moencopi the lines of Lombardy poplars bordering the streets of Tuba City shone bright above the sand dunes. Beneath these black-green sentinels, planted by pioneers whom the Mormon Church sent forth to reclaim the desert, and now sheltering the western agency of the Navajo, we paused at sundown. When the journey was resumed, darkness had fallen, blotting out the landscape, but the motor droned onward until half past one in the morning when it halted before the trading post of Wetherill and Colville at Kayenta, one hundred and sixty miles northeast of Flagstaff.

Usually a trading post is a tawdry place, an ugly accretionary growth fabricated of all sorts of material from sunflower stalks and mud to the boards from packing cases. Such a characterization, applicable to the generality of trading posts, does not fit Kayenta, for there is blue grass in front of the low stone buildings, the vine-hung walls of which show dimly through rows of elder trees. Within the living room of the residence Colonel Roosevelt and other men of distinction have sat and discussed with the courteous hosts the craft of the frontiersman and the lore of the aborigines, and departed enriched by the experience.

It was after mid-day on June 28 that our cavalcade left the Flagstaff-Kayenta road at Marsh Pass and turned westward into the mouth of Segi or Laguna Cañon. At half past nine we encamped for the night in a little, sage-grown opening among the scrub oak and aspens near the head of a side cañon that enters the Segi from the left. On the follow-

*A record of the Bernheimer Expedition of 1921.



Old Reliable.—The desert horse is sure-footed beyond the ordinary conception and may be trusted to pick its way over any obstacle which a man can cross unaided by his hands

ing morning the imposing cliff dwelling known as Betatakin (Side Hill House) loomed high and clear above us, its hundred rooms receding tier after tier upon the shelving floor of an enormous concavity in the northern cliff. Betatakin is the second largest ruin in the Navajo National Monument. It has been excavated and skillfully repaired, and together with the many other ruins in the Segi and its branches may be considered the nucleus of an archaeological area in importance second to none in the Southwest.

While we were examining and photographing Betatakin, a shout from down the cañon announced the arrival of an expected member of the party. The group was now complete and consisted of Mr. Bernheimer, John Wetherill, Ezekiel Johnson, Al Smith, Necloeybadani (The Laughing Man's Son-in-law), and the writer. Johnson, the new arrival, was to have joined us at Kayenta. When he failed to put in an appearance,

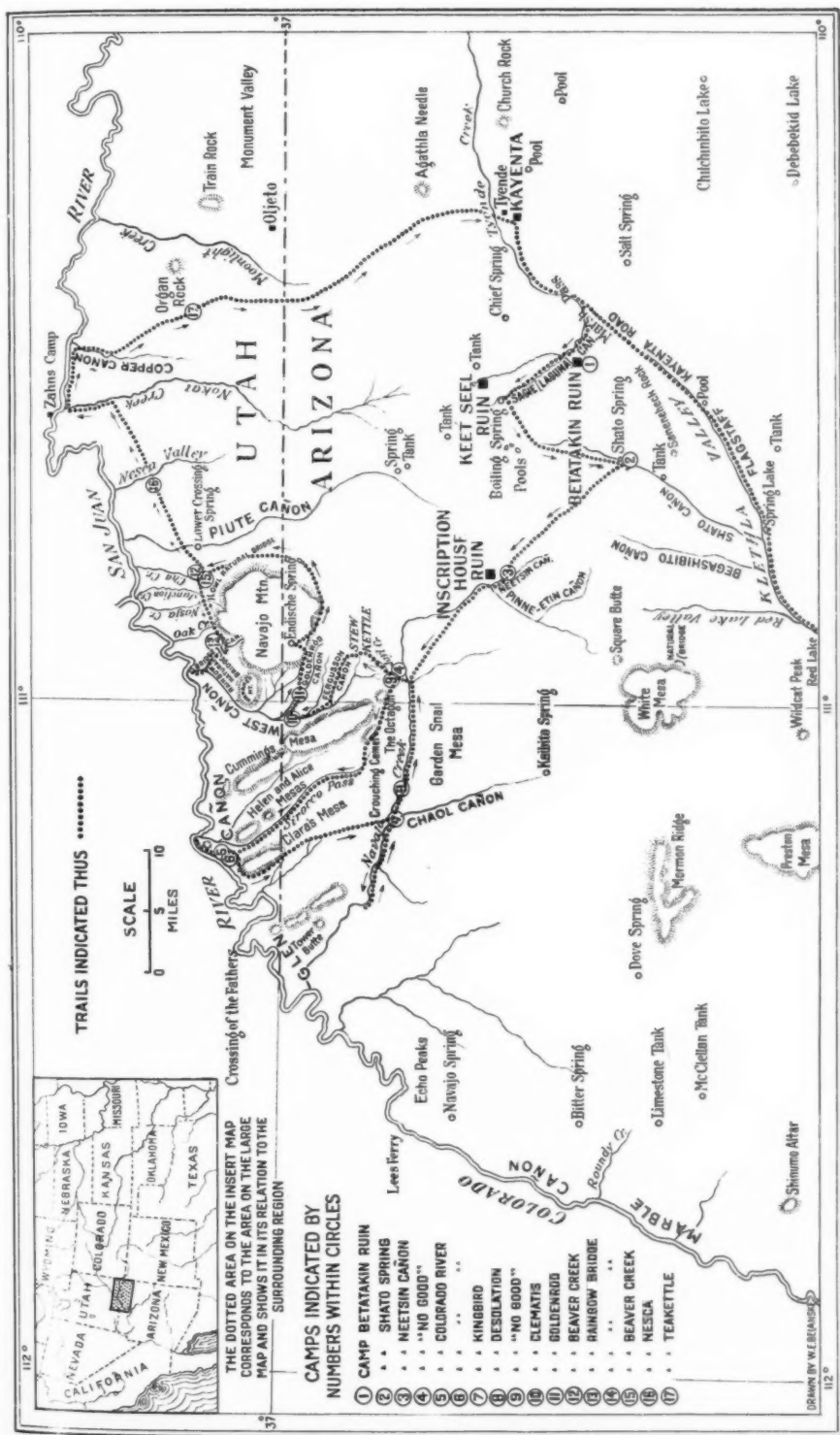
we became apprehensive lest in coming across country from Blanding, Utah, he had been waylaid by the Piutes, who just then were in an ugly mood owing to the leaden vengeance which had been visited upon one of their number subsequent to thefts from the herds of the Mormons.

Freed of our anxiety, we were soon under way again, and the six riders and eleven pack animals wound in single file out of Betatakin Cañon and up the Segi. The trail was crooked and usually skirted the talus owing to the necessity of avoiding the arroyo and confluent washes, which have cut deep into the valley floor. A generation ago the bottom of the Segi was for miles a chainlike series of pools, hence the Spanish name, Laguna; but the only remaining traces of them are hardened bands of black muck in the arroyo banks and occasional patches of moribund reeds, the dwindling remnant of the greenery with which they were fringed.

After some miles the towering left wall of the cañon broke down into a series of ledges up which the trail zigzagged; from the rim rock the path led southwestward over a rolling mesa through forests of piñon and juniper interspersed with numerous sage-clad glades.

Noon of the next day found us beyond the divide which separates the drainage of the Little Colorado from that of its master stream, encamped beside a spring in Neetsin Cañon. Here because of the humidity from the spring, the heat was almost unendurable; yet the beauty of the greensward upon which the camp was spread, the clear streamlet which issued from beneath a ledge, and the line of Scottish thistles leaning forward from the rock on either side of it, each bright with purple bloom, soon banished thoughts of physical discomfort.

Inscription House, a large and important cliff dwelling which takes its name from an almost illegible inscription in Spanish, scratched on one of the walls in 1661, is situated in the lower reaches



ROUTE OF THE BERNHEIMER EXPEDITION, 1921



Drawings in white on the wall of Navajo Cañon.—There is no key to the meaning of these ancient rock markings. Conjecture is interesting but fruitless

of Neetsin Cañon. There we spent the afternoon photographing the ruin and collecting the beautiful fragments of pottery which litter the talus at the foot of the cliff. These fragments were the more durable portion of the refuse which the inhabitants of the cliff house tossed out of their front doors and over the brink of the ledge.

As we were returning to camp, there emerged from a crevice in the cliff what appeared to be a compact mass of foliage possessed of the power of locomotion. The suspicions of our mules were at once aroused, but we stayed their flight until the curious object came close enough for

us to observe four hoofs beneath the waving greenery, and a dark head protruding from the top of it. It was merely a Navajo horseman returning homeward from some side cañon with half a wagon load of long, cottonwood branches—enough to roof a summer house—piled before and behind him across his mount.

There were two or three inhabited *hogans* in Navajo Cañon below the mouth of Neetsin. As we passed these on the following morning, the branches were being put in place on top of a scaffolding of poles. Acres of thriving young corn, watered by irrigation, surrounded the *hogans*, and westward of them stood a few large peach trees, gnarled veterans of many winters.

To avoid a long northward bend of the cañon we climbed out on the western side and were again on a rolling mesa. This stretch was a veritable desert. The entire foreground was composed of wavelike ridges and hummocks of wind-blown sand, while in the distance the buttes and towers along the Colorado River, dim and softened in outline, were visible through a sort of sunset haze. There were no trees except an occasional stunted piñon rooted in the crevices of a sandstone outcrop, but now and then we passed clumps of an evergreen shrub, which it was a pleasure to look upon. This bush, *Lepargyrea rotundifolia*,¹ resembling boxwood, grows always in dense, solitary clusters, sometimes six feet in height. The branches are thickly set with leathery leaves, which are slow to wither after they have been plucked. The silvery green foliage would make an excellent substitute for holly, and the shrub itself is easily worthy of a place in cultivated gardens.

Late in the afternoon we rode down the rib of a sand dune into Navajo Cañon about eighteen miles northwestward from Inscription House, at the mouth of Jayi Cañon, a northern tributary. In

¹The only two specimens of this plant ever brought out of the desert and replanted are now growing in the New York Botanical Gardens, Bronx Park, to which they were presented by Mr. Charles L. Bernheimer.



A ledge trail in Bridge Cañon.—Where a V-shaped gorge in the cañon bottom makes travel there impossible, the path winds along a ribbon of talus between receding ledges

the angle of the watercourses, in both of which diminutive streams were flowing, there was a remnant of a level valley floor on which stood a *hogan* and a few peach trees. Two or three Indian families were encamped there with their flocks of sheep.

Wetherill had been as far as Jayi before, but the country lying westward and northwestward toward the Colorado River had not been penetrated by white men, unless perhaps by some fugitive from justice or misguided prospector who had failed to leave a record of the fact. Natsisan (Navajo Mountain), a powerful, thick-bodied Navajo, with little Oriental moustaches hanging from the extremities of his upper lip, had journeyed with us from the settlement at the mouth of Neetsin Cañon. Twice in his youth he had been to the great river

(Colorado), and upon him we depended for knowledge of the trails. He said there were two: one, very rough, by which the distances could be covered in a day; the other, less difficult but much longer, would require at least two days. The shorter route was chosen.

All unnecessary impedimenta, including reserve supplies of food, corn for the animals, and most of our personal baggage was cached in a ravine at Jayi, and on the morning of July 2 we set out, this time with Natsisan riding in the lead. The trail ascended in a northwesterly direction to the foot of a knife-edged ridge hundreds of feet in height. The profile of this landmark suggested to Mr. Bernheimer the form of a crouching camel, and it was so named. At the head of the camel the trail seemed to end at the brink of a chaos of wind-furrowed



Clara's Mesa.—This impressive formation towers over a sea of oddly shaped bald rocks. A perfect replica of a Prussian spiked helmet may be seen in the dark cove on its westerly face

rocks so rough and precipitous that one would have judged it impossible for any creature larger than a chipmunk to climb down over them to the lower country beyond. The Indian was puzzled and appealed to Mr. Wetherill to find a continuation of the trail. The latter dismounted and, as if by instinct, led off around an abruptly sloping shoulder where the faintest suggestion of a ledge gave just room enough for the animals to place their feet. At this and a dozen other places passed in the descent, the consequences of a misstep on the part of man or beast were unpleasant to contemplate.

An hour later the haunts of eolian erosion lay behind us, and the animals were munching the corn from their nose bags on a strip of sand beside a water pocket in the rocks. They were a motley lot, ranging in size from a misshapen, ragged-coated mule scarcely larger than a Shetland pony to Johnson's saddle animal, which had the proportions of a city draft horse. But each and every one was a veteran of the trail, sure-footed and dependable to the last degree,—qualifications which were essential and

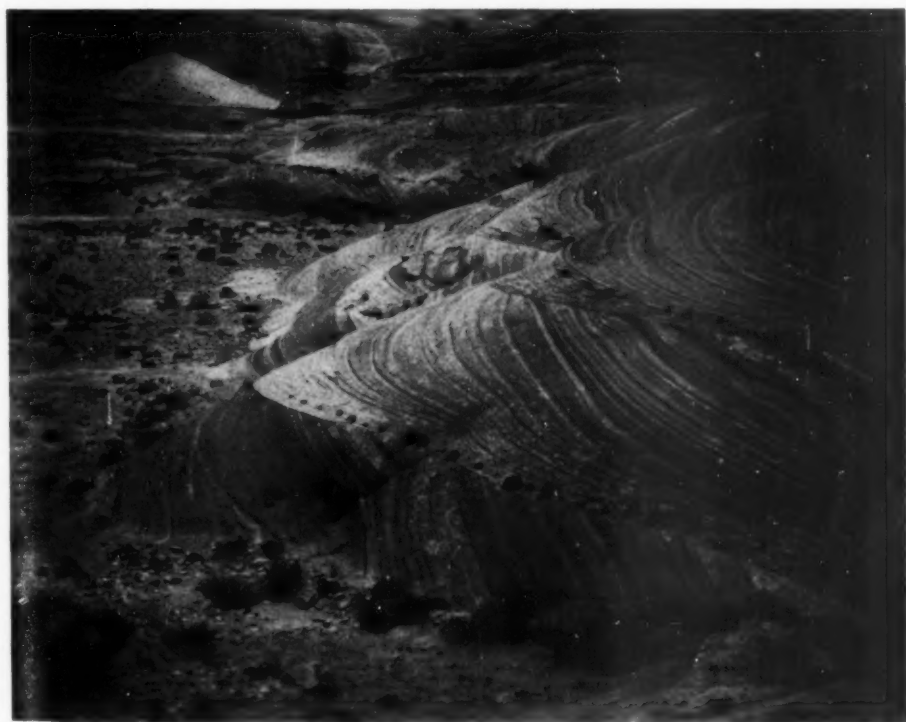
overshadowed all shortcomings of appearance and disposition.

The afternoon's ride was down the dry, sandy bottom of a valley which began at the "Crouching Camel" and ended at the Colorado River. All of the way a gale blew in our faces, at times so heavily laden with sharp, stinging sand that we rode with lowered heads, trusting to the animals to keep the proper course. That evening, in camp beside a willow thicket on the bank of the Colorado, Mr. Bernheimer, mindful of the wind storm, named the valley "Sirocco Pass."

We had come to the Colorado River primarily in search of a spot of unknown location, the Crossing of the Fathers, where in 1772, Escalante, while returning from his memorable journey of exploration from Santa Fe, in what is now New Mexico, to central Utah, had forded the dangerous stream and made his way thence to the Hopi towns. At the mouth of Sirocco Pass the course of the Colorado is nearly east and west. Between the water's edge and the south cliff there is a strip of level ground nearly a mile long and an average of one hundred yards in width. From the eastern



The eastern side of Cummings Mesa.—Cummings Mesa is a table-land nine miles long and six miles wide. A single precarious footpath gives access to the level summit, which was a refuge for the cliff dwellers in prehistoric times and for renegade Navajos in more recent years



Slick rocks on the east bank of the Colorado River.—These solidified sand dunes, resculptured by the agency which formed them, are a portion of the barrier between Sirocco Pass and the Cañon of the Colorado

end of the flat there is a practicable route for a crossing, and also evidence of a trail leading up the northern cliff, hence the conclusion that our objective had been reached. Later, however, close questioning of Natsisan revealed that the object of our search lay some five miles farther down the river, where, as mentioned by Escalante, the water in pouring over a bar or reef is so shallow that, except in flood time, horses can ford without difficulty. Formerly the crossing was much used by the Navajo, who each winter drove off many horses, cattle, and even sheep from southern Utah with positive assurance that they were safe from reprisal once they had the spoils of their raids across the river. Eventually the Mormons, tried to the limit of their patience, brought down a few donkey loads of dynamite and blew out of existence the approach to the ford on the Utah side. It was so dire a calamity to the aspiring Indian herdsmen that news of it spread from one end of the reservation to the other in less than forty-eight hours.

The scenery along the Colorado was of a different character from that presented by the country to the southeastward, and evidently is the product of two cycles of erosion. During the first cycle the major portion of the original plateau was cut down about one thousand feet to a fairly uniform plane. The numerous isolated remnants of the plateau are sheer-walled, flat-topped buttes and mesas of vermilion-colored sandstone, usually capped with a greenish white band of harder, sedimentary material. Fully twenty of these buttes, distributed on both sides of the river, were visible from the mouth of Sirocco Pass. Because of their vast size, attractive coloring, and the singular beauty of their wind-sculptured walls, they are fully as magnificent as the better known monuments for which Monument Valley is famous.

At the base plane of the monuments degradation must have been negligible

for a long period. Then the Colorado cut through some barrier to the southward and ground out a new cañon for itself, which process was taken up in lesser degree by the minor confluent. The ragged, tortuous cañons—such as the one traversed by Sirocco Pass—are the results of this second cycle. The primary mouth of the latter is fully a mile wide and well back from the river, whereas the present mouth is a vertical slot in the river wall not more than twenty-five feet in width.

We became attached to the level strip bordering the river at the mouth of Sirocco Pass because of the interesting things which were observed there. As we were examining a very old trail which led down the cliff to the western end of the flat, a black-tail doe sprang out of the rabbit brush below us and scurried away toward the other extremity of the level land. When we had tracked her eastward as far as she could go, she darted past us again, and in a willow thicket where the river met the cliff we found her two spotted fawns. These three deer were the only ones which Mr. Wetherill had seen in the Navajo country in all the years of his experience. Evidently the doe swam the river from the northward side in the spring before the fawns were born, and finding herself in a place where feed was plentiful, chose to remain there indefinitely. At no stage of the journey were forms of reptile life numerous, yet not far from where the doe was first seen there darted from the underbrush a lizard which evaded all our attempts to capture it. It was a brownish creature more than a foot long, with a fairly thick body and a broad tail adorned on each side with a longitudinal row of scarlet dots. This species, whatever it may have been, was new both to Mr. Wetherill and to the writer.

The night of July 4 found us for a third time in Navajo Cañon, but on this occasion at the mouth of Chaol Cañon, a southern branch which heads near Kaibito Springs. This point later proved to



Mr. Charles L. Bernheimer beneath an ancient piñon tree.—Here and there in the desert a piñon tree spreads its gnarled and distorted branches above a few square feet of sand, offering to the traveler a grateful respite from glaring sunlight and parching heat

be a day's ride westward from Jayi. The supply of grain for the animals was nearly exhausted, and in consequence, on the morning of the fifth the party was divided, Mr. Bernheimer, Mr. Wetherill, and the writer remaining behind to investigate the western portion of Navajo Cañon, the other members setting out for Jayi. Under the guidance of Dogistlanibega (Many Whiskers' Son) we rode westward to within ten miles of the Colorado River, where, in the northern cliff, there were two small ruins, the only ones which the Indian had observed below the mouth of Chaol Cañon. Most of the way the trail lay in the bed of the stream, which was by no means the impassable quagmire of quicksand that had halted all previous attempts to travel down the cañon. The Indian explained that five years previous to our visit a herd of cattle had wintered in the cañon, and that in wandering back and forth

they had tramped and solidified the quicksand until it was no longer troublesome at any point between the mouth of Chaol Cañon and the river.

On the border of the stream, Dogistlanibega had two little cornfields and a few hills of melons, which he pointed out with great pride—a pride well justified in a year of such unusual drought. A flock of sheep and goats was being herded by three of his small children, who at our approach fled into the underbrush like rabbits. We commented upon the fact that the days must seem dull to these little folks, separated by many miles from all others of their kind, but before long we concluded that their ingenuity was equal to the circumstances and that they were not at a loss to find something with which to amuse themselves. There was a playhouse at the side of a large boulder half buried in the sand. Four bits of driftwood, set up like posts,



NONAME MESA WITH NAVAJO

This view, taken between Goldenrod Cañon and Endische Spring, includes some of the roughest country to be found in the entire region

formed the outlines of an enclosure. Within it were a number of crude toy dishes of the children's own making, red like the earth of all this country: bowls, cups, tiny pots, one with three legs and a clay ball that filled it, and several cooky-shaped disks of clay.

That part of Navajo Cañon between the Kaibito branch and Jayi proved to be the most desolate stretch that we encountered anywhere. The torrents of recent years had swept away nearly all of the soil, which previously supported groves of cottonwoods and willows, the white, barkless trunks and branches of which were strewn about among the boulders like dismembered skeletons. Our camp the night of July 5 was upon a dried mud flat where there was not a spear of grass for the animals and only chocolate-colored water to drink. The western species of *Datura* was the only conspicuous growing thing to be seen anywhere. The great, solitary, blue-green plants, laden with immense,

trumpet-shaped flowers of waxy whiteness, presented an impressive contrast to the naked stones about them.

Our party reunited, we headed northward from Jayi on the morning of the seventh. Beyond the eastern end of the high ridge of which the Crouching Camel was the crest, lay a vast depression which we named the "Stew Kettle." It was a maze of tortuous cañons winding in and out among dumpling-like knobs of rock, too hopelessly rough to be crossed by a pack train. Veering westward we found the head of Fergusson Cañon, followed that to its junction with West Cañon, and journeyed down the latter until falls in the watercourse and sheer cliffs on either side put an end to our hopes of continuing northward to the Colorado. An adequate conception of the ruggedness of this particular region cannot be conveyed in words. About 85 per cent of it is bare rock. Less than half a mile west of our night station in West Cañon, which we named "Clema-



MOUNTAIN AT THE RIGHT

The panorama does not reveal the presence of three major cañons which lie five hundred feet beneath what appears to be the base plane of the foreground

tis Camp," Cummings Mesa—a long, narrow remnant of the original plateau—towered to a height of fully 1500 feet. Not more than ten miles to the eastward lay the pine-clad crest of Navajo Mountain at an elevation of 10,416 feet, probably 6000 feet above Clematis Camp. In looking from the foot of Cummings Mesa toward Navajo Mountain, the foreground might be likened to a sea driven in the teeth of a hurricane, the waves of which at their height had been transfixed to salmon-colored stone.

We had failed in our attempt to find a second route to the Rainbow Bridge by following West Cañon around the end of Navajo Mountain. Inasmuch as we were going to the bridge, there was no alternative but to strike eastward until we intersected the known trail.

On July 8 we netted only three miles. At sundown we were in an eastern bi-furcation of West Cañon to which the name of "Goldenrod Cañon" was given. This soil-floored furrow in the

rocks was perhaps three or four miles long, and at no point more than seventy-five yards in width, a diminutive bit of the great wilderness but as beautiful as it was small. Groves of cottonwood darkened the shadows cast by the cliffs, and the grasses brushed the horses' bellies as they grazed. Luxuriant growths of goldenrod thrust their gaudy heads above the meadows, clematis vines draped fallen tree trunks in robes of downy white, giant *Datura* towered above the greenery around them, and lesser flowers, pink, blue, and violet, were visible among the grasses as these parted before one's feet.

These conditions were a sample of the past which had survived into the present, and in them lay the answer to a question which has perplexed many an observer. In Goldenrod Cañon and a thousand other cañons in the Southwest remains of the homes and handiwork of prehistoric agriculturists are much in evidence. It is plain that once fields of corn and beans and squash flourished where now there



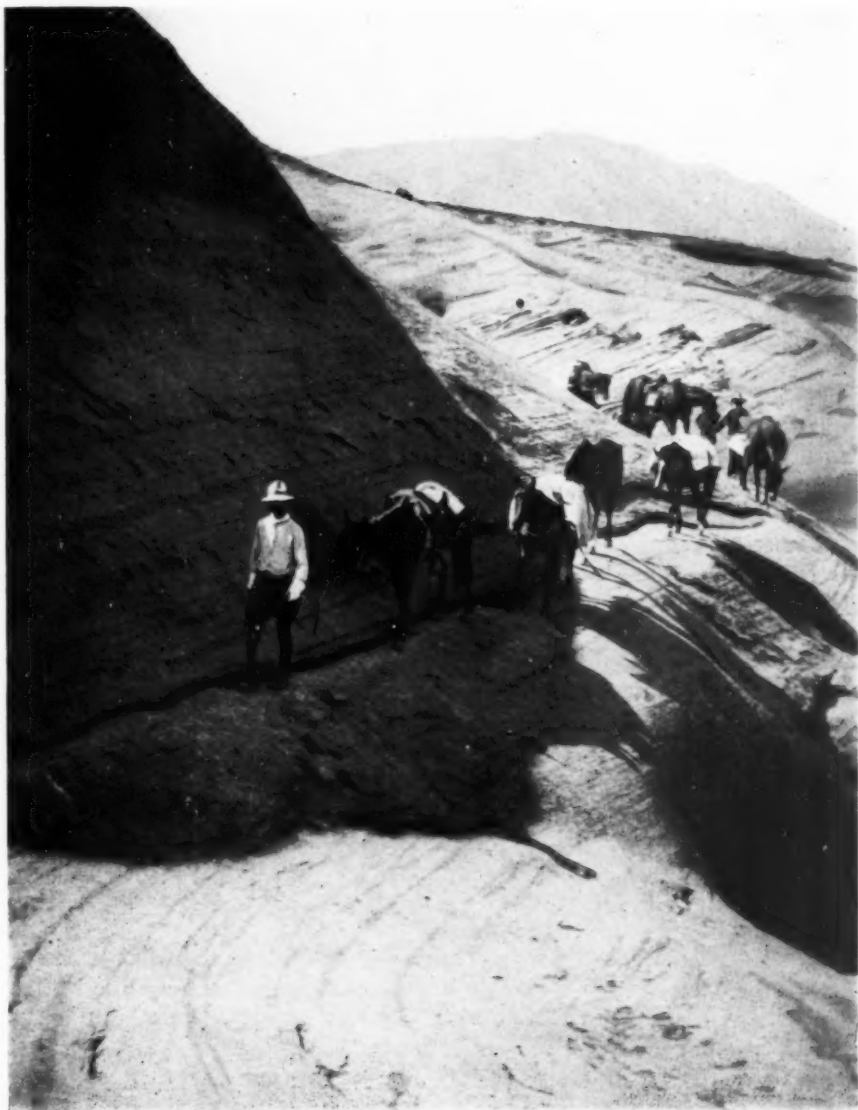
Crossing the slick rocks.—These expanses of bare, wind-swept sandstone lie between Surprise Valley and Bridge Cañon. Only an experienced tracker can follow the Wetherill trail across them

is no soil at all, or what remains is as guiltless of vegetation as a city street. Here was Goldenrod Cañon, a natural garden, and just across the ridge, Navajo Cañon, desolation incarnate. As they were side by side, climatic changes and fluctuations in rainfall could not be called upon to explain the difference between them. Horses, sheep, and cattle had

seldom ranged into the rough country as far as Goldenrod Cañon, while the upper reaches of Navajo Cañon had for generations been a grazing ground for the flocks and herds of the Indians. The prehistoric aborigines had no domesticated browsing animals. In their time the vegetation matured, died, and accumulated where it grew, forming a net

which caught and spread the run-off from the showers over all nearly level stretches, whether portions of mesa top or valley floor. The moisture thus retarded soaked in and was retained by the soil. Within the past century the ranges were all overstocked. The protective coating was removed, the new grass was eaten

before it could produce seed, and the tramping herds destroyed the sod, thus laying the soil bare before the onrush of water which followed each heavy rain. Cutting began and has continued to such an extent that the whole broad land is scarred and furrowed with numberless arroyos, each one a drain ditch as effec-



A difficult ledge among the slick rocks.—This is the most dangerous bit of trail on the way to the Rainbow Bridge and more than one animal has lost its footing and fallen to death in the chasm beneath

tive as if designed by an engineer. The overstocking of the ranges and consequent formation of arroyos, rather than an absolute lack of moisture, may be held accountable for the barrenness of much of the Southwest today.

On the afternoon of the tenth the bridles were slipped from our tired mounts beneath the Rainbow Natural Bridge. The bridge is not more than six or eight miles in an air line from Clematis and Goldenrod camps, but to get there we had ridden fully fifty miles, and in so doing had made almost the complete circuit of Navajo Mountain.

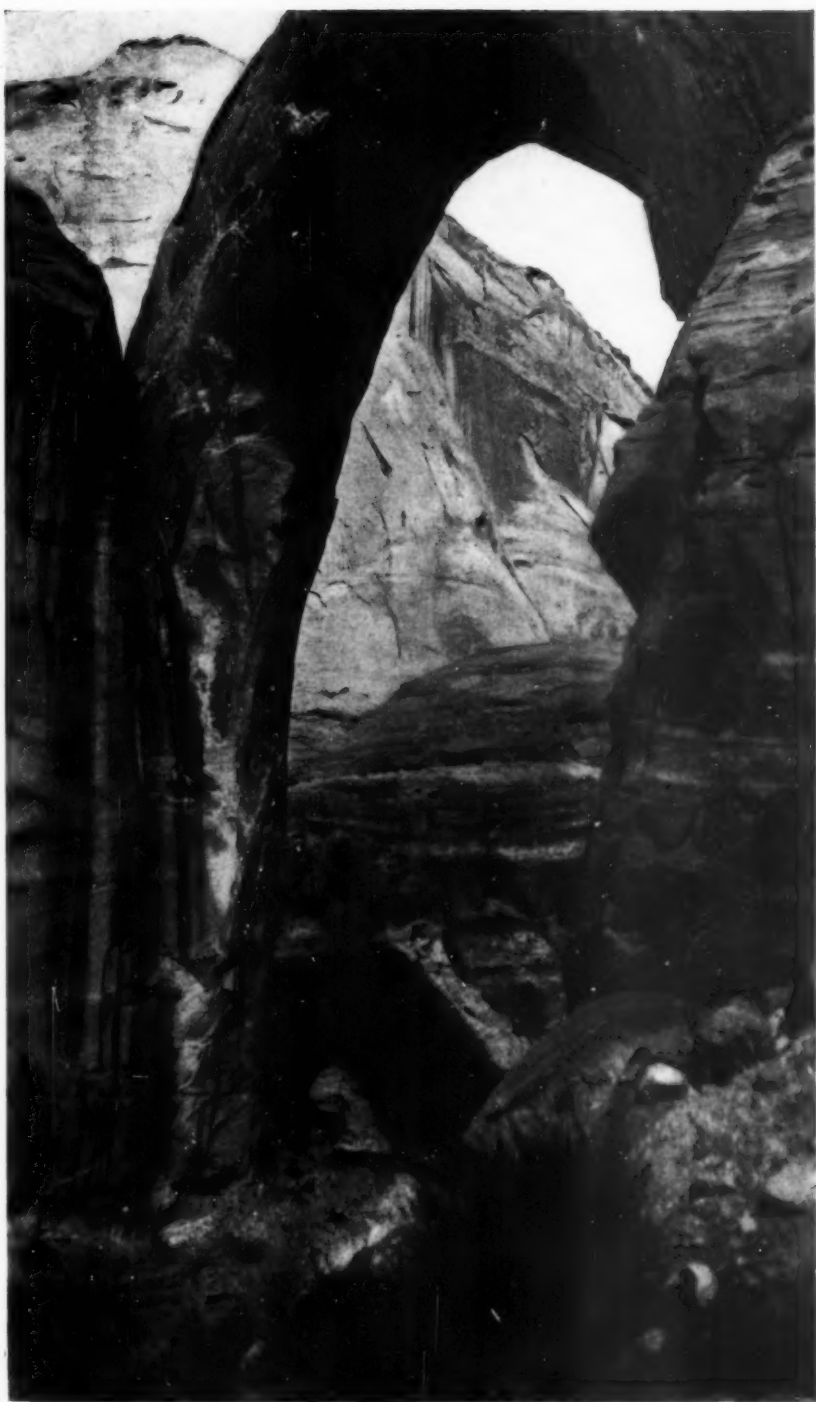
Individual opinions, of course, might vary, but in the estimation of the writer there exists nowhere a more majestic and impressive natural object than the Rainbow Bridge. The name is confusing, for the strange product of erosion to which it is applied is in no sense a bridge, but an enormous arch with a span of 274 feet and a height of 308. The eastern end sweeps upward from an ancient valley floor, while the western extremity is buttressed by a shoulder of the cliff. So true are the proportions, so perfect the symmetry of the gigantic bow of stone that when gazing upward at it, one unconsciously bares one's head in reverence to the Master Architect whose handiwork it is. The fact that the aborigines shared this sentiment is evidenced by the ruins of two ancient altars in the shadow of the eastern base.

The Rainbow Bridge spans a cañon that carries the drainage from a part of Navajo Mountain northward to the Colorado River. The cañon is narrow, crooked, and in places from 800 to 1000 feet deep. The waters deepened their ragged groove through the soft, reddish sandstone of the plateau until a stratum of greater hardness was encountered. This stratum was slow to wear away, and its surface constituted the cañon floor for a very long time during which lateral erosion was, if anything, augmented. Where the bridge now stands, there was an abrupt horseshoe turn, the

toe pointing toward the east. Indeed, the mechanism of the process by which the bridge was formed may be readily understood if the cañon at this point is visualized as an enormous horseshoe of which the inner and outer edges of the metal are the cañon walls. The sand-laden flood waters dashed against the inner wall at the right side of the heel, were obliquely deflected toward the outer wall, swirled along it past the toe, and were hurled once more across the channel to strike against the inner wall at the left extremity of the heel. Thus the tongue of stone which filled the horseshoe was subjected to maximum abrasion where it was thinnest, that is, between the points of the heel. Eventually the impinging currents pierced the barrier between them, and thereafter the stream shortened its course by flowing through the breach of its own making, beneath the beginnings of the arch that millenniums later the Piute were to name The Rainbow.

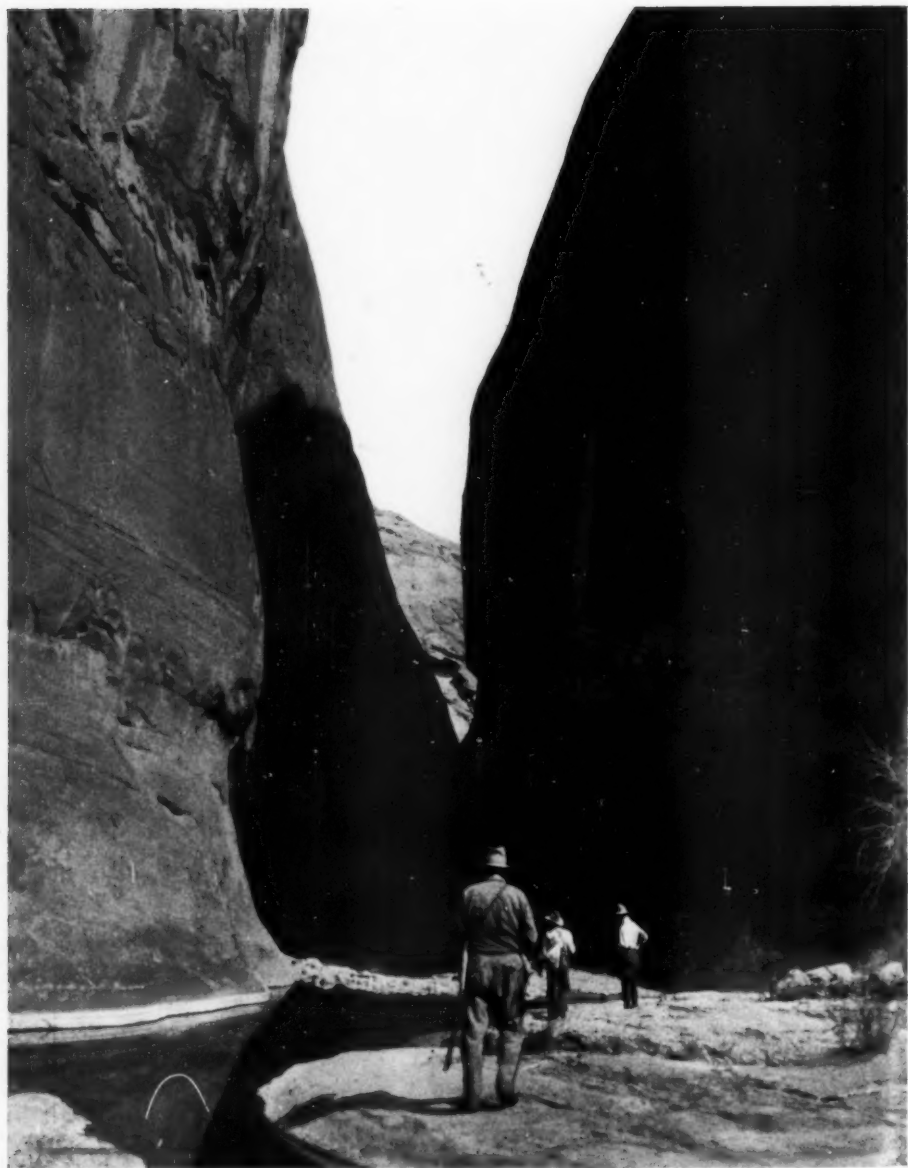
The first white men to view the bridge were the members of a party headed by John Wetherill and Professor Byron Cummings, who reached the spot on July 5, 1909. To Mr. Wetherill is due the credit for the discovery, for it was he who learned of the natural marvel from the Piutes, and it was his skill which blazed a trail to it through a country so rugged that it would have discouraged anyone less experienced. Probably had the task remained for others to do, the Rainbow Bridge would have continued to be unknown for another generation or two.

Few of those who visit the bridge go on down the cañon to the Colorado River, thereby missing some of the most beautiful scenery the country has to offer. The trip can be made on horseback with no particular difficulty. In many places the reddish cliffs, streaked and mottled with darker stains, are so high that they seem almost to meet overhead. There are deep, clear pools in the stream bed, and cool springs well up through crevices



THE RAINBOW NATURAL BRIDGE AND ITS SHADOW

Imposing, tremendous, and perfectly symmetrical, the vast arch is equally impressive regardless of the angle from which it is seen



THE MOUTH OF BRIDGE CAÑON

Even at noonday the towering cliffs cast deep and somber shadows upon the pools and banded walls of this water-hewn gateway to the Colorado River

in the rock. Some four miles below the bridge, Bridge Cañon empties into West Cañon through a slot so narrow that it resembles a gigantic doorway, whence even at midday one stares from twilight shadow into a dazzling glare of sunlight. The remaining two miles to the river consist of a succession of pools larger than those in Bridge Cañon. In many of these pools beaver dwell, and some of them the crafty animals have considerably enlarged by the construction of dams. In one of the ponds thus empounded there were catfish which in the clear water looked as black as lumps of coal. Two of the swart creatures were swimming round and round a clump of moss from which they seemed loath to depart. A poke with a stick sent swarms of inhabitants scurrying from the moss. They were tiny catfish, no longer than the first joint of one's finger. Can it be that some fish guard their young, or were the larger members of the tribe merely contemplating the toothsome meal promised by the younger fry?

There are several small cliff houses in West Cañon. In one, situated beneath an overhang where the clear streamlet loses itself among the turbid waters of the Colorado, there was a crude vessel fashioned from a piece of driftwood, and several names were written in charcoal upon the cliff. Some of the prospectors who are wont to ply along the river in the wintertime, washing gold from the gravel bars, had taken shelter in the ancient home of a people whose hearts knew not the lure of the yellow metal.

The Rainbow Bridge having been photographed from every possible angle, the final aim of the trip had been accom-

plished, and there remained but the journey homeward. On the night of the twelfth we camped for a second time on a ledge overlooking Beaver Creek. There was a threat of storm, but after a brief shower the black clouds rolled by and the morning dawned clear. The packs were nearly empty of food and grain, so some of the animals could be dispensed with. Those so footsore that they could scarcely travel were left behind to recuperate in a cliff-walled pocket where there were both grass and water.

From the northeast skirt of Navajo Mountain there are two trails to Kayenta. In order to avoid scenery that would have been an old story to several members of the party, we followed the arc rather than the chord of the bow. This led us northeastward over a less rugged country to the San Juan River at the mouth of Nokai Cañon, and thence east and south through Copper Cañon and the western edge of Monument Valley. In mid-afternoon of July 15 we wound past the gaunt spire of the Agathla Needle, and straightway the animals lengthened their stride on glimpsing familiar trails at the end of which they knew there would be at least a brief respite from the rigors of the march.

We had been out eighteen days without illness, accident, or disagreement; we had ridden on horseback fully four hundred miles, and had charted and named cañons, prehistoric ruins, and landmarks not indicated on existing maps; we had taken probably the most complete photographic record of the Rainbow Bridge which has been made up to the present, and from the crest of the Comb Ridge we were once more in sight of the elder trees at Kayenta.



THE HAUNT OF THE LYRE BIRD

The lyre bird (*Menura*), which derives its name from the lyre-shaped arrangement of the tail feathers of the male bird when spread in courtship, is partial to fern gullies. The present picture was taken in Victoria



The nest mound of the lowan (*Leipoo ocellata*) must be ranked among the greatest of ornithological marvels. The male as well as the female bird participates in the construction of the mound, which is usually about twelve feet in diameter and from two to four feet in height. In the egg chamber, which, it is said, attains a temperature of from 90° to 96° Fahrenheit, and hence is an ideal incubator, as many as three tiers of eggs are laid

AUSTRALIA'S WONDERFUL WILD LIFE

BY

CHARLES BARRETT, C. M. Z. S.*

OUR camp was pitched in a grove of gum tree (*Eucalyptus*) saplings, with a swamp almost at the "front door," and a vast tract of wild country stretching away to the north. While the "billy" boiled, my mates and I smoked and yarned, or paused to catch the cries of unseen birds—owls and "mopokes" (the Bushman's name for the frogmouth, *Podargus strigoides*).

At dawn we were waking, eager for our first excursion into the trackless country—the incult Mallee of northwestern Victoria. Mallee is the name for several species of small eucalypts, which form dense thickets, or grow in clumps amid shrubs and spinifex (*Triodia*) on sandy soil or good ground fit for agriculture.

There are big sand ridges in the Mallee, crested with Murray pines, valuable as timber. All these lands were classed formerly as "desert," but vast areas have been reclaimed and, year after year, yield fine crops of wheat.

We had come to the wilds—the uncleared Mallee—to study and photograph birds; for the Mallee country is famous as the home of the lowan (*Leipoo ocellata*) and many other beautiful and interesting species.

As we entered the "desert," a lowan ran across our track in a leisurely way as if it were unafraid of man. But these birds, now becoming rare, are, as a rule, shy and wary, and usually only swift glimpses of them are obtained. Their flesh is good food, and some settlers,

*First President, Nature Photographers' Club of Australia.

though the species is protected by the game laws, know well the taste of it. The fox, however—an alien from Europe, which is one of our worst pests now—kills many lowans or Mallee-hens, and robs their nest mounds.

"Thermometer bird" is one of the popular names for the lowan, the nesting habits of which are remarkable. Both the male and female birds are industrious, each pair constructing a huge mound of sandy soil and vegetable debris. The material often is brought from places some distance from the mound site. The birds scrape it along the ground with their powerful feet, and it is said that the wings also are used to aid in transport. The preliminary work (even if an old mound is renovated) is done in the autumn, and the mound is left open. Before the time of winter rains, the lowans scrape debris into the hollow of the cone, and cease work, perhaps for several months, until the heap of material has become sodden; a layer of sand is then added. Another period of waiting ensues; but at length the hotbed is ready and the egg-laying begins.

The eggs, which are much larger than those of a turkey and of a delicate pinkish brown color, are deposited in tiers, in a vertical position. They are enveloped in sand, a stratum of which protects each tier. The egg chamber is one of nature's incubators, "invented" ages before man learned how to hatch eggs by artificial means. In the hotbed a temperature of from 90 to 96 degrees Fahrenheit is generated. The parents escape the dreary task of brooding, but they visit their mound at intervals and work at it in order to prevent consolidation, and to make it easy for the chicks hatched from eggs of the lower tiers to reach the surface and escape from darkness into the light.

The lowan, which is also called "native pheasant," is rather like a young turkey, but more graceful and with some claims to beauty. Its color scheme is fawn, gray, black, and brown; the

wings and back are spotted with white. The food of the lowan consists chiefly of seeds and ants, which abound in its haunts.

I have seen many mounds of the lowan, but during the trip I am describing I had little luck in finding them. It was disappointing. Still, we had no reason for complaint when we reviewed our experiences on the last day. On the banks of a little lake, calm and blue as a summer sky, we saw scores of the splendid "smoker," or black-tailed parrot (*Polytelis melanura*), and discovered the nests of this bird in hollows. This lonely place, in fact, was the headquarters of the species, which is protected because of its rarity. The male is a glorious bird, with greenish yellow head and neck, and the shoulders and under parts yellow. Flying in the sunshine, it is like a long flake of gold, tipped with shining black—the tail feathers. The female is not so brightly colored.

The "smokers'" nurseries were in hollows in gum tree boles, or big spouted limbs, from fifteen feet to forty feet above the ground. We saw birds leave home in a hurry as we passed close to their respective trees. The eucalypts, old and gray and gnarled, were rich in hollows, and nearly every one had feathered tenants. Not all of these cavities were occupied by "smokers." There were happy families of ring-neck parrots (*Barnardius barnardi*), dressed in bright green, with a yellow band on the hind neck; little hollows were tenanted by musk lorikeets (*Glossopsitta concinna*) green of plumage, with splashes of red behind the ears; while white cockatoos (*Cacatua galerita*) and pink cockatoos (*Cacatua leadbeateri*) were also rearing broods.

Our advent caused a great stir in this bit of birdland. The parrots protested, and cockatoos screeched defiance and anger, wheeling over the trees with their crests erected. There is, perhaps, no noisier bird in the world than the white cockatoo—its notes seem to rend the air.



A young pink cockatoo (*Cacatua leadbeateri*) voicing its demands

Still I, for one, like to hear them, because of their wildness. There is little danger of this species becoming rare, but its cousin (*Cacatua leadbeateri*) is not so fortunately situated. In its plumage this bird displays delicate salmon pink and white; the crest is crimson, white, and yellow. Prized as a pet, the pink cockatoo becomes too often a victim of the trapper. In the fledgling stage, both cockatoos and parrots are taken from

their homes in hollows, conveyed to towns and cities, and hawked in the streets. They find a ready sale at prices ranging from about a dollar upward, and large numbers have been despatched overseas.

White cockatoos are no friends of the farmers, for they revel in a wheat field. Immense flocks are often seen, whitening the ground like a fall of snow, or perched in trees. They post sentinels, it is said—

birds that keep watch from lofty boughs and utter a shrill cry of warning at the least sign of danger, whereupon the whole flock takes wing.

In the Mallee we saw only small groups of cockatoos. Splendid they looked in flight, like big snowflakes against the blue of a cloudless sky. Sunshine and sky color, I hold, are used by nature cunningly to gain her finest effects with wild birds on the wing.

Of lesser birds the Mallee country has a rich variety. The wren warblers, with their long, up-tilted tails, are among the most beautiful. One species, *Malurus assimilis*, is purplish blue on the back; another is cobalt blue with white wings. The blue wrens—there are many species—build domed grass nests close to the ground, and are favorite dupes of the shining bronze cuckoos. It is a strange fact that, although they resemble each other closely, one of the species of bronze cuckoos lays a bronze-green egg and another an egg that is white with pinkish

red spots and similar to those of the wren warblers among which it is so often placed.

The Mallee has its own variety of emu wren (*Stipiturus malachurus mallee*), a brown, fairy-like bird, with a patch of sky-blue on the throat, and a marvelous fan of tail feathers loosely webbed and carried erect in miniature emu plumes. These tiny birds creep through the undergrowth, or make quick, darting flights, low over the bushes.

We heard, close to our camp, the notes of the crested bell bird (*Oreoica cristata*), a clever ventriloquist, which sometimes fools a stockman seeking horses. I have been fooled myself by a bell bird, thinking it many yards away, when it was calling from a bough close by. The notes are clear and musical; but, as a songster, the ventriloquist cannot rival the whistlers (*Pachycephala*), which, indeed, are master minstrels. If I were asked to select a team of Australian birds to sing against the famous songsters of



A nesting haunt of cockatoos and parrots in New South Wales

Europe or America, my choice would be the rufous-breasted whistler (*Pachycephala rufiventris*), the lyre bird (*Menura superba*), the magpie or piping crow shrike (*Gymnorhina leuconota*), and one of the fly eaters (*Gerygone sp.*).

The lyre bird, which takes high rank as a mimic, haunts fern gullies in ranges that lie far from the Mallee country, and many happy days have I spent in its haunts.

pearled moss, starred with brilliant fungi, crimson and yellow and purple-red—while picking my way through a tangle of logs and creepers to the edge of the little creek, which sang a ripple song across the pebbles. It was pleasant to ramble among the tree ferns, the noble fronds of which, like giant umbrellas, shut out the sunlight. It was moist and green and silent in the haunt of the lyre bird.



The dancing mound of the lyre bird.—These mounds, a few inches in height, are made of light sand. The male bird struts about on them, raising and spreading his beautiful tail even though the admiring female is not always present to behold his antics

We have three species of *Menura*. All are superb voice artists, and notable for grace. I am most familiar with the Victoria lyre bird (*Menura victoriae*), which is not uncommon within a score of miles of my suburban home. One day I went to the ranges with field glass and camera, to hunt for these birds. From a tree-bordered track I plunged into the heart of fernland, brushing raindrops from a hundred drooping fronds and stepping softly on the dead leaves of unnumbered years—deep mold covered with dew-

Presently, as I leaned lightly against the trunk of a tree fern, the silence was broken by shrill cries that echoed down the gully. A lyre bird chick, startled in its nursery, had given the signal of distress. The nest, a round mass of sticks and rootlets, larger than a prize watermelon, was wedged between two fern trunks just above my head. Usually *Menura* builds close to the ground, but in districts where foxes abound it has taken to nesting among the lofty boughs, to baffle the furred raiders.

The young bird's cries of fear and distress were quickly heeded. A female *Menura* came flying on to a branch close to the nest and above it, and regarded me with misgiving. When I climbed to the nest and thrust a hand into the interior, the baby bird screamed again; and when I descended to the ground, the mother bird took my place. She was suspicious but not really frightened. At least she remained at the nest, or near it, while I fixed the camera on a tripod, and focussed on her favorite perch. Three plates were exposed at close range; only dim light and flickering shadows spoiled a chance of securing perfect pictures.

Later, when lunching by the creekside, I heard a male lyre bird give his own call, and then proceed to imitate the calls and songs of many other species. He mimicked a flock of parrots, as they call when on the wing, the strange notes of the coachwhip bird (*Psophodes crepitans*), and a score of other familiar voices of the bush. And when he had gone through his repertoire, he began again and repeated the performance with variations. Some Australian naturalists claim supremacy for the lyre bird as a musical mimic. He is wonderful; but I have not heard the mocking bird of America, and shall not venture on comparisons.

On hill slopes in the ranges I discovered several small circular clearings, slightly raised, and with the earth "worked over." These were dancing mounds. Male lyre birds are, perhaps, not accomplished dancers, but they seem to find pleasure in strutting about and capering on the mounds that they make. One bird may use four or five mounds. These displays may please the females, but often they are given without spectators.

Where *Menura* is, you will hear or see the pilot bird (*Pycnoptilus floccosus*), a small, dark brown species which appears to be as fond of the lyre bird's company as the pilot fish is of that of the shark. It is likely that "cupboard love" is the reason for this companionship. Pilot birds pick up "crumbs" from their big

friends' table, as it were, gleaning in the wake of the hunter as it scratches over the moss and tears decayed logs to fragments. "Guinea-a-week," are words that the *Pycnoptilus* seems to call as it forages.

In the gullies, too, I heard the coachwhip bird, but rarely saw it, for it keeps under cover. A sprightly black bird, crested, and with white cheek patches, it builds a saucer-shaped nest of rootlets, placed at no great height in a tangle of wire grass or creepers. The eggs (two to a clutch) are beautiful—blue with sepia or black markings, like hieroglyphics or Arabic characters.

In the ranges I had an old bark hut, named "Walden," after the slab dwelling near Concord, where Thoreau observed wild nature's ways. My "Walden Hut" stood in an untended garden, with a bush track as one boundary and a creek for another. Here, with two brother naturalists, I spent week-ends and holidays, year after year, until war broke the sequence. We wandered all over the district and gathered a rich harvest of field notes and photographs.

At night, sitting quietly in front of the shack, often we witnessed the aerial skill of flying phalangiers (*Petauroides volans*), or "squirrels," as they are commonly called in Australia. Creeping to the end of a dead gum-tree bough, about sixty feet high, each little animal, black on the upper surface and white underneath, would crouch and then leap into space, with the loose skin along either side of the body expanded. The "flight" was a gliding dive, ending on the trunk of a tree some distance from the "leaping-off place." Just before the end of its journey through the air, the "squirrel" would turn upward, as a man does after a dive in the sea, and alight on the tree bole neatly. Then up it would climb, perhaps to repeat the performance.

The lesser flying phalanger (*Petauroides breviceps*) was much rarer in our district (about thirty miles from Mel-

bourne, the capital of Victoria) than the big species. One we captured, and it became a charming pet, bright-eyed, soft-furred, and graceful in all its ways. It soon lost its fear and acquired a taste for sweetened milk and biscuits. It would

ivy; swallows under the back eaves; and other small birds in the garden or down by the creek. A list of species would be wearisome; yet I must mention our friends the kookaburras (*Dacelo gigas*), which nested in a hollow, high up in the



The coachwhip bird (*Psophodes*) which dwells in fern gullies and rarely appears in the open, derives its name from the terminal note of its vigorous song, which is clear and sharp as the crack of a coachman's whip. The nest is often placed in a low bush screened by thick underbrush. The eggs are among the most beautiful: sky-blue with curious black markings

"fly" from the back of a high chair on to a window ledge, and would sometimes alight, softly as thistledown, on its master's shoulder.

We made excursions far and near, but wild life near the hut never failed to repay attention. Blue wrens nested in the

trunk of a gum tree growing near Walden Hut. They reared two fledglings one season, near the end of summer. We enjoyed every day the gurgling, laughing notes of a quartette of these great brown kingfishers or "laughing Jacks," as most people call the kookaburras.



A young kookaburra (*Dacelo gigas*).—The eggs, a beautiful pearl-white, are frequently laid in a hole in a gum tree, the decomposed wood at the base making a soft bedding for the nestlings. Rather devoid of shyness, even inquisitive, the kookaburra is an engaging bird, with which one is glad to make friends

The "opossums" of Australia are, of course, not entitled to the name; they differ, both in structure and habits, from the American opossum. Around the hut ring-tailed phalangers (*Pseudochirus peregrinus*) were plentiful. In our rambles we came upon their big round nests—built among branches a dozen feet or more from the ground.

The *Pseudochirus peregrinus* we saw, but not the species that every Australian

zoölogist longs to behold. Leadbeater's opossum (*Gymnobelideus leadbeateri*) is, in fact, the rarest of all the marsupials if, indeed, it be not extinct. Less than six specimens have been obtained—all from a small area on the Bass River, Victoria. The habitat has been searched again and again, yet not a glimpse of the animal has rewarded the seekers. I shall go to Bass River myself very soon—not to collect, but to see and photograph the



A young ring-tailed phalanger, one of the interesting Australian marsupials



Nest, in an *Acacia* tree, of the ring-tailed phalanger (*Pseudochirus peregrinus*) commonly called an "opossum."—These marsupials are found in abundance in southern Australia and are very popular as pets. They build nests about the size of a football, of fern fronds, dead leaves, and other materials

haunts of a beautiful creature which doubtless has gone from the world forever.

Our creek at Walden was fringed with wattles (*Acacia*), which dusted the water with gold in springtime and sheltered a thousand wild birds. Here the gray thrush (*Colluricincla harmonica*) sang

at dawn and after, the name of an American bird, bobwhite, sounding in its song—"bob, bob, bob whit-e." Here there were honey eaters, golden tufted and olive green, and shrike robins (*Eopsaltria australis*) with yellow breasts.

The fact that there was a stream suggested the possible presence of the platy-



AN AUSTRALIAN "TEDDY BEAR" AND ITS CUB

Although called the native bear, there is a vast gulf between this animal, the koala (*Phascolarctus*), and bears as we know them in other parts of the world. The koala is a marsupial and such resemblance as it has to the true bear is merely superficial.

pus, or duckbill; but, though we went quietly at twilight, we did not see one in our creek. Farther afield, fortune was kinder. After sundown, in an upper reach of the Yarra River, glimpses of the platypus were won. We never saw one ashore, though the duckbill does make little land journeys, crawling awkwardly. Like penguins these paradoxical creatures are clumsy out of their element; but in it, swift and graceful.

Occasionally the platypus is found in the net of a river fisherman. It is rarely seen, except by those who know its ways and observe a studied quiet. A lover of shadows, the duckbill avoids sunlit reaches on its home stream. To see it you should be by creek or river when the day is young or at sunset, for these are its hours for feeding.

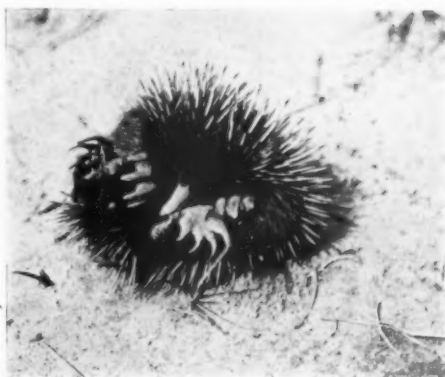
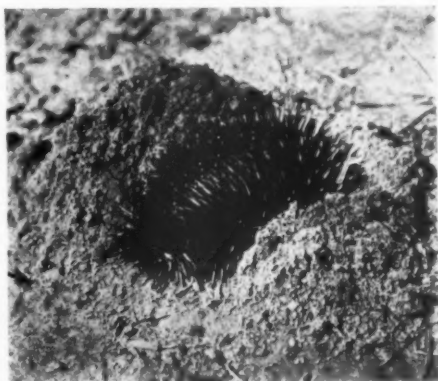
In the last few years our knowledge of the duckbill's habits, of its domestic life, has been increased by studies in the field. Mr. Harry Burrell, of Sydney, New South Wales, has watched the animals at work and at play; he has explored their long burrows and has collected specimens in all stages. In brief, he has gathered material for a full dress biography of *Ornithorhynchus anatinus*.

I have chosen and pieced together stray notes from the book of my wanderings in Australian wilds—the book of golden memories, which gains fresh pages every year. A month ago I was camped on a lake with subtropical scrubs along the shore. From my tent, a stone's throw from the jungle, every day after sunrise I saw full-plumaged males of the regent bower bird (*Sericulus chrysocephalus*). Splendid in orange-gold and black, they came from a tall tree into the open to feed on inkweed berries.

In the morning chorus I distinguished the call of the cat bird (*Ailurædus smithii*), another member of the bower bird family. Its notes, like the mewing of a cat, earned the bird its trivial name.

I went south to Sydney, where a day

of rare luck in the National Park gave me records of another species of brown bird. The park is a pleasure resort for the people of a great city, yet it contains thousands of wild birds that rear their broods in safety within sound of human



(Above) The echidna (*Echidna aculeata*) burrowing.—This animal is a strong and speedy digger. Disturbed, where it has no chance to go underground quickly, it rolls itself into a ball, head and legs tucked in, and thus often escapes harm.

(Below) The echidna ready for the enemy.—The echidna is not inappropriately known as the Australian hedgehog or Australian porcupine.

laughter and song. The picnickers do not disturb them. Lyre birds run across the roadway, and close to the Rest House you may find the playground of the satin bower bird.

One male of *Ptilonorhynchus holosericeus* has a wonderful bower, within six



A STRUCTURE OF THE SATIN BOWER BIRD

The bower, or playing place, constructed by this bird, is frequently ornamented with gaily colored or shiny objects that this bird has pilfered,—the blue tail feathers of certain parakeets, bleached bones, the shells of snails, pebbles, berries, bits of china, broken glass, and the like, being among the odds and ends enumerated by different authors

feet of a road which, during the week-ends, is traversed by hundreds of motor cars. Concealed by a log, I watched the satin bird come to his play place. He entered the bower, removed a bit of orange peel, and had a general look around, unconscious that a nature lover was in hiding barely a yard away. Sun-light gleamed on his blue-black plumage, lustrous as satin, and on the beautiful blue eyes. A cough broke the spell and my bower bird flew off to join his mate in a tree across the highway. The female and immature males of this species are greenish gray, with crescent-shaped markings of dark brown on feathers of the

under surface of the body. The males become "blue" birds when about seven years old.

When we spread a meal near its bower in the park, the friendly satin bird became a welcome guest. To encourage him we sat in a wide circle around the "board," a white cloth on the grass, and remained silent and still. For a while he gazed longingly, then dropped from his perch in a gum tree into the midst of plenty. He pecked at a ham sandwich, sampled the cake, and reflected. Another beakful of sandwich, then back among the boughs,—a pleasant incident for a naturalist to store in memory!



The black swan (*Chenopsis atrata*) is found in Tasmania as well as in Australia

WINDOWLESS MUSEUMS

BY

FREDERIC A. LUCAS*

LIGHT is the great enemy of natural history collections: the lovely Luna moth fades after a few days—almost after a few hours' exposure; birds lose their brilliancy and the feathers of humming birds actually seem to disintegrate on long exposure to light; a few years ruin mammals like deer and foxes, and such seemingly fast colors as black turn reddish. Some minerals even are affected by light, and Rose Quartz, instead of getting heightened color, pales in the sunshine and must be kept in the dark if her charming complexion is to be preserved indefinitely.

So the visitor to the mammal gallery of the British Museum of Natural History may find the shades drawn and labels calling attention to the fact that it is done to preserve the specimens, and in many continental museums the galleries are shrouded in darkness save for a few hours on stated occasions.

And yet light is necessary if visitors are to see and enjoy the exhibits of a museum; so museum authorities have been more and more perplexed as museums have become more and more popular, by the problem of having plenty of light and at the same time of preserving specimens for posterity.

The most harmful rays are the ultra-violet. Science has done so many wonderful things that it seemed within the range of her abilities to devise a light filter that should keep out the dangerous actinic rays while letting the others pass, and Sir William Crookes gave much time and thought to this problem.

Green or yellow glass, it was ascertained, acted as such a filter, but there was the objection that the light was not white, an objection which was answered at the Victoria and Albert Museum by using green and orange glass in such

proportions that the result was a white light. When the exhibit of colonies of bacteria was installed in the department of public health, American Museum, some of them "broke down" after a short exposure to light, though that light came through heavily frosted glass. Pale yellow glass was then placed in front of the frosted glass and since that time none of the colonies have broken down.

Similarly, in the hall of North American mammals it was found that frosting the windows on the southern side did not suffice to cut out the glare of the winter sun and the lunettes were fitted with pale yellow "cathedral" glass, which seems both to cut out harmful rays and diffuse the light. That this light is not white seems a negligible consideration, the more so as in many of the groups shown in the Museum white light has been carefully avoided.

Frosted glass was used as the result of certain experiments made about ten years ago by Dr. R. W. Tower. By means of the spectroscope he showed that frosted glass cut out a goodly share of the ultra-violet rays, and that electric light, and especially that passing through frosted bulbs, was much less harmful than sunlight. The object of this experiment was, literally, to throw light on the question of the possible injury to specimens in "habitat groups" illuminated continuously by electric light, and on the still larger problem of what would be the effect of discarding daylight and relying solely on electricity for lighting museum buildings. Electric light has many advantages; it shines when and where it is wanted and—barring accidents—it shines at all times with the same degree of intensity.

About the same time Doctor Tower made his demonstration, Dr. S. F.

*Director of the American Museum

Harmer (now Sir Sidney), director of the British Museum of Natural History, began a series of experiments with a variety of objects submitted to light of various kinds, and the results of these experiments, carried on for about ten years, he has published in *The Museums Journal* (of Great Britain) for April, 1922. The last of these experiments was with a number of objects exposed continuously to different kinds of light for a period of 1030 days, nearly three years. They show conclusively that electric light is much less harmful than daylight, and Sir Sidney concludes his article with the sentence, "A gallery without windows, lighted entirely by electric light, preferably not arc lights, would have great advantages."

It is interesting to note that this series of experiments, carried on over a period of nearly ten years, corroborates the deductions made from Doctor Tower's observation with the spectroscope, but it is a little discouraging to find that, so far, a transparent, non-actinic glass—and Sir Sidney experimented with several kinds—is a failure. It would seem, therefore, that we must turn to electric light for help in our difficulties, and it is possible that these may be solved by its use, plus a ray filter.

There would be other advantages in the use of electric light, for it would mean among other things that all, or nearly all, wall space could be utilized, that there would be no dark corners in exhibition halls, and that summer and winter there would be the same degree of illumination. Modern improvements in lamps have made it possible to secure almost any quality of light up to pure white, and some of us may live to see the time when museums of natural history will be constructed without windows.

In this country the advocates of museums illuminated solely by electric

light are Doctor Matthew and Doctor Stejneger. Doctor Matthew has figured that the gain in wall space from the omission of windows would offset the cost of the electric light. Some architects have begun to consider the problem. Mr. Carl E. Akeley and Mr. Alfred F. Rosenheim also have planned halls to be lighted with electric light only. While these were halls for "habitat groups," yet it is probable that they are the forerunners of the windowless museum.

■ In closing, it is of interest to quote the conclusions which Sir Sidney Harmer drew from one of his experiments:

(a) Darkness, even if accompanied by a considerable rise in temperature, is a complete protection to fugitive colours.

(b) Moisture in the air assists fading and is probably essential to it.

(c) The rays of the blue, violet and ultra-violet parts of the spectrum are particularly injurious, as shown by the marked superiority of glass 38 [a yellow-green glass, of decided colour] over the others used. These rays are not, however, the only ones to be feared, as in direct sunlight fugitive colours projected by this glass became practically bleached after a prolonged exposure.

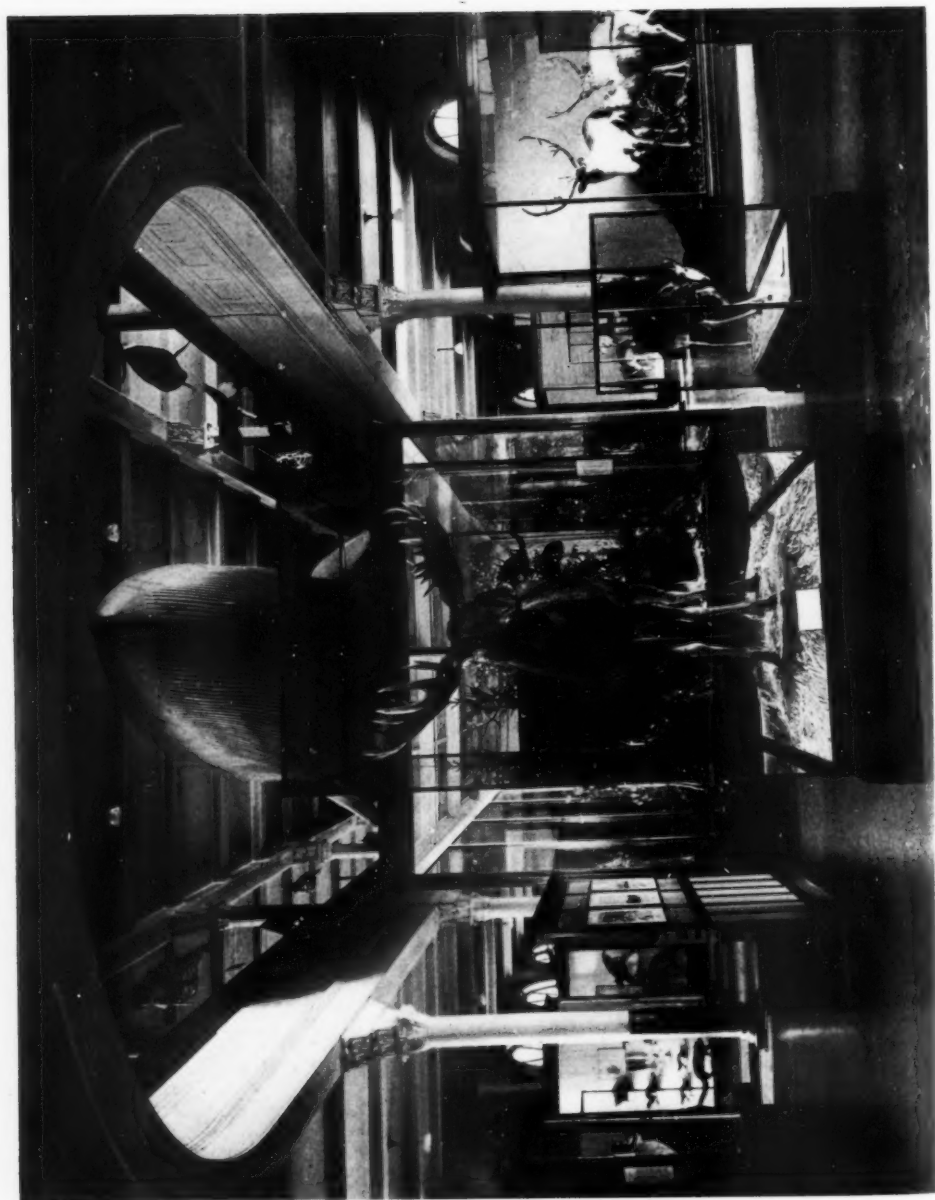
(d) Other glasses, of less pronounced colour than 38, but agreeing with it in cutting off part of the violet end of the spectrum, afforded some protection, and in the initial stages of the experiment were always slightly superior to ordinary window-glass. The protection was only partial, having the effect of merely prolonging the period necessary for complete fading.

(e) Fading was found to take place much more quickly in fugitive artificial pigments than in natural objects, some of which showed no change at the end of the experiment, even if exposed to direct sunlight.

(f) Direct sunlight was much more injurious to colours than any other form of illumination used.

(g) Diffused daylight appeared to be on the whole slightly more injurious than any form of electric light.

(h) Of the electric lamps used, the Half-Watt gave the best results. The Arc-lamp was probably the most injurious, the equal amount of fading produced, in some cases, by the Filament-lamp having to be discounted by the fact that the latter was continuously alight and was placed much nearer the objects.



ALLEN HALL OF NORTH AMERICAN MAMMALS, AMERICAN MUSEUM

THE DEPARTMENT OF MAMMALS, AMERICAN MUSEUM

A HALF CENTURY OF ACHIEVEMENT

BY

H. E. ANTHONY*

IN THE early history of the American Museum, which began in 1869, with Professor A. S. Bickmore as the first head of the department of mammals, there was but the one department to cover both mammals and birds, as well as other branches of zoölogy, and the Museum was starting with empty exhibition halls and empty storage cases. The beginnings of the collection of mounted mammals go back to the purchase of the Maximilian collection, followed by the acquisition of collections made by Verreaux and Vedray. Magnificent as these were in their day, they have long since ceased to be an exhibition feature and now are interesting solely as historical specimens, while the general public has forgotten that they ever existed. The reason for this has been the great influx of material since that time and the marvelous strides made in the methods of preserving and exhibiting mammals. But back of this progress and directly responsible for it is the evolution and development of ideas.

Fifty years ago a museum was judged by different standards and few had guessed at the possibilities of natural science. The increase in the size and number of exhibition halls, the constantly rising standards of exhibition, the accumulation of many thousands of study specimens, and the volumes of research publications brought before the public, have followed inevitably as the result of the glimpsing of these possibilities and their exploitation by the naturalist.

Dr. Frank M. Chapman has clearly set forth the aims of a department of birds,¹ which may be summarized briefly

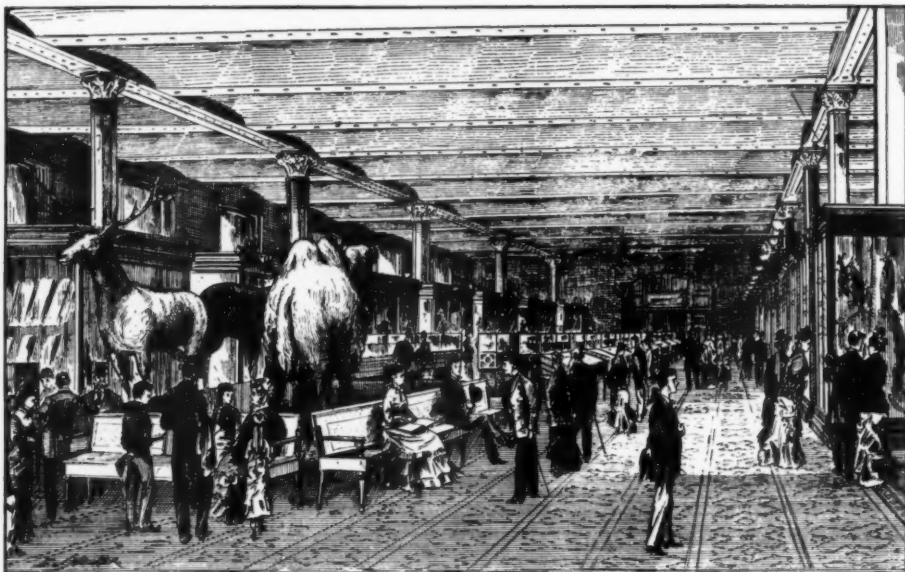
as the ability to answer any inquiry concerning birds, their place in nature, and their relation to man. The department of mammals encounters very much the same kind of problems as does the department of birds and strives to present to the public the facts of its science through the same media, namely groups and exhibits, publications and lectures.

To the general public the most obvious function of a department of mammals is the planning of exhibition groups and the satisfaction of the usual normal curiosity of the layman, who wants to see in striking external characters the difference between the fox and the wolf, or the deer and the caribou. Consequently, this brief résumé of department history will be largely concerned with this phase of its development. However, so varied are the queries addressed to the department of mammals in a large museum and so diverse the demands made upon it that, ranging from the theoretical to the practical, it may be called upon to decide wagers as to whether the whale was physically able to swallow Jonah, or to give advice as to how disturbing colonies of bats may be driven out of church towers; while questions of significant economic importance include the relations of rodent pests to the farmer, carnivorous mammals to the stockman, and fur-bearing mammals to the world at large. Only by constantly delving for facts, by unremitting research, can the department fulfill the expectations of the public.

The first serious attempt at the inauguration of a department of mammalogy began with the curatorship of the late Dr. Joel Asaph Allen. He came to the American Museum in 1885, fresh

¹NATURAL HISTORY, July-August, 1922, pp. 306-18.

*Associate Curator of Mammals of the Western Hemisphere [In Charge].



This view of the old North American mammal hall, taken from the *Daily Graphic*, New York, December 22, 1877, should be contrasted with that of the same hall—remodeled and lately rechristened Allen Hall of North American Mammals—as it appears to-day (see frontispiece of this article). From “stuffed” mammals, surrounded by benches, to modeled animals shown in their habitat is a great stride forward and measures the artistic development of taxidermy

from the Museum of Comparative Zoölogy at Cambridge, where he had been steeped in the lore of Louis Agassiz. Doctor Allen found no mammals in the study series and but a mere handful of mounted mammals in the exhibition series. With characteristic energy he set about the enlargement of both. At first he did all his own cataloguing and labeling, not only of the mammals but of the birds as well, for the two departments were not separated until 1920. From this small beginning the collections began to grow by leaps and bounds, and additional personnel, beginning with Dr. Frank M. Chapman, who joined Doctor Allen in 1888, came into the department.

Today the staff of the department of mammals consists of ten members. With the growth of the activities of the American Museum all over the globe, and the consequent accumulation of material, it was found advisable to divide the field covered by the department into two subdivisions, resulting in the present organization. In the table that follows,

the date preceding the name of an individual signifies the year of his entering the department.

- 1906 Roy Chapman Andrews, associate curator of mammals of the Eastern Hemisphere.
- 1911 H. E. Anthony, associate curator of mammals of the Western Hemisphere.
- 1915 Herbert E. Lang, assistant curator, African mammals.
- 1921 Carl E. Akeley, associate in mammalogy.
- 1911 Miss Agnes F. Molloy, secretary.
- 1917 Miss Ruth D. Evans, secretary.
- 1919 Mrs. Helen Ziska, department artist.
- 1920 T. Donald Carter, department assistant, Eastern Hemisphere.
- 1920 George G. Goodwin, department assistant, Western Hemisphere.
- 1916 Arthur J. Dougherty, department assistant.

The two associate curators have full charge of the field work and research in their respective branches of study, and by a division of this nature there is less likelihood of duplication or confusion of endeavor. The field to be covered is so large that in no other way can intensive work be successfully attempted.

The early ideas of museum exhibition gave rise to halls filled with a large

number of specimens mounted as individuals, the emphasis being upon the number of different species which might be assembled. The fact that often many of the species were so similar that such a display soon acquired an appearance of monotonous familiarity for the visitor did not act as a deterrent to this tendency. The large collection of Primates upon exhibition presented, for instance, long series of monkeys grasping limbs, facing the visitor or staring one another out of countenance, rubbing noses or tails as their pedestals happened to be turned. Such an exhibition made many strange companions, and the larger it became, the more heterogeneous it grew. Painted backgrounds, accessory material, and an attempt at natural grouping were all developments of what might be termed the zoölogical renaissance, which was just beginning to make itself felt. The larger mammals—deer, bear, etc.—were stuffed, with such generous employment of plaster of Paris that they could be moved only with difficulty, while the art of the sculptor and modeler was conspicuously absent.

The department took a step in the right direction, and with the installation of the bison group began a series that was to become dominant in the mammal halls. This group was a carefully planned attempt to tell something of the life of the bison, showing not only a natural grouping of several individuals in characteristic poses, but much of this mammal's environment as well. This is a "habitat" group and its exhibition value is many fold that of an equal number of individually mounted bison. The moose group followed in 1895, and thereafter many groups came into being, each based upon the conception that something more than the size and color of an animal must be shown, and with the completion of each group came experience and increased appreciation of the possibilities inherent in the method.

A hall, designated as the North

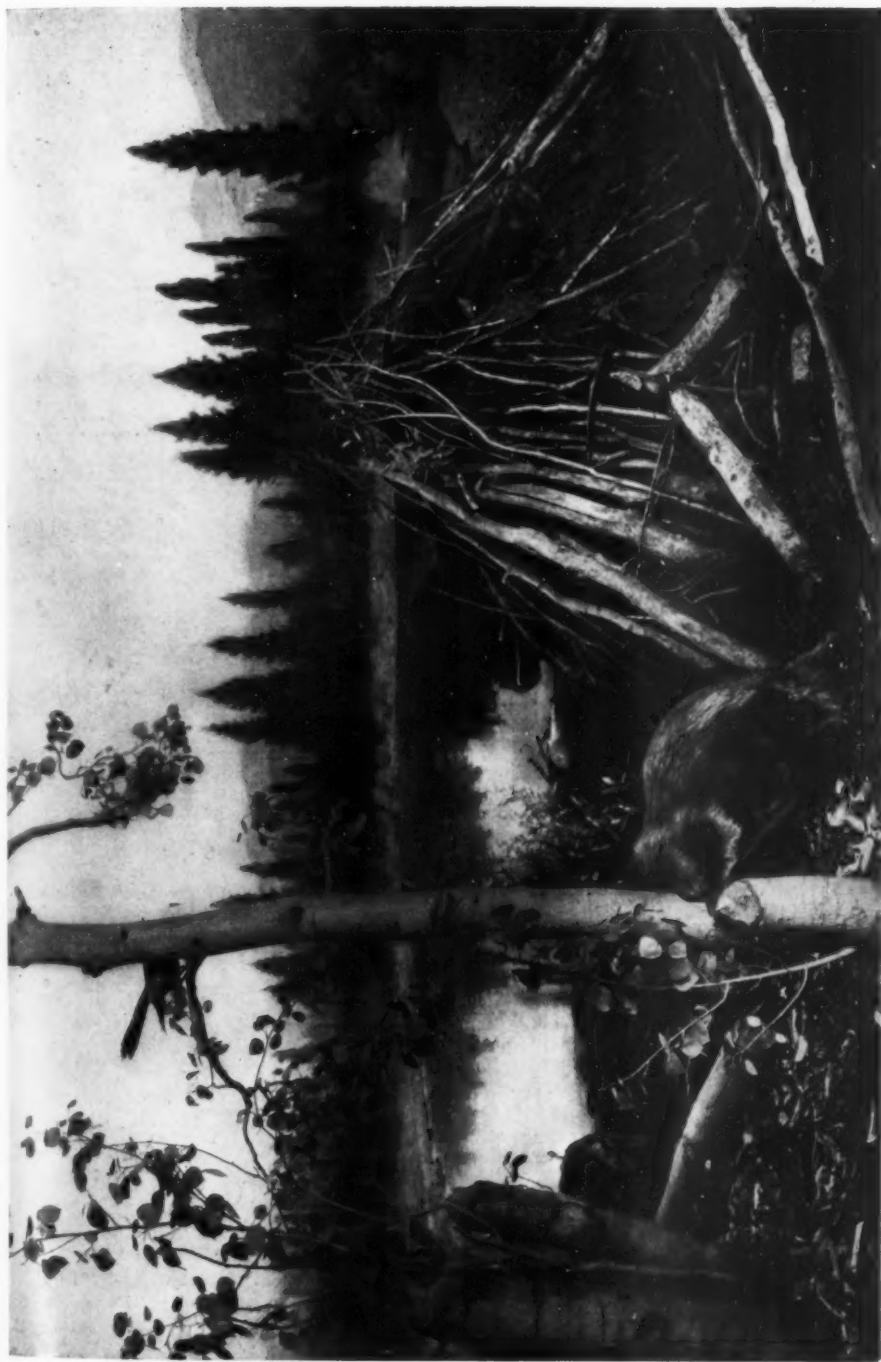
American mammal hall, was given over entirely to mammals of that continent and plans were evolved for similar halls devoted to other continents: one for South America, another for Asia, a third for Africa, a fourth for the marine mammals, and a fifth for Australia. Unfortunately for the realization of this plan, the halls have been in existence only on paper, and the valuable material being held for mounting cannot be utilized for lack of exhibition space. Every possible foot of floor space has been filled and some excellent groups have been installed, gradually driving out the older mounts of the Maximilian and Verreaux collections until today the habitat group is the rule rather than the exception. There can be no question that this change has been approved by the public. Among the more notable of these groups, some of which are today exhibited under circumstances which prohibit the fullest possible display of every feature, are those of the wapiti, the pronghorn, muskox, caribou, beaver, wolf, elephant-seal, and many others as well. Huge mammals, such as the whale, have been placed on exhibition, as well as a group of stupendous African elephants. The progress in methods of preparation has so far advanced that the largest mounted mammals may be moved with ease, and yet are far more permanent than the heavy mounts of fifty years ago. Great as has been the development and improvement of the mounted mammal exhibits, the expansion and attainment would have been even more impressive had they not been held in check by the lack of hall space.

Recent developments, whereby the Museum has received appropriations for new buildings, promise an opportunity for much-needed growth and expansion. A spacious hall of marine life will have exhibits of the whales, porpoises, and other cetaceans. Material for this hall has been collected by Mr. Roy Chapman Andrews in many seas, and comprises

MR. CARL E. AKELEY
AT WORK

He who builds up a modern group of mammals must first of all know his animals, secondly he must visualize the best possible result to be attained, following which he must call forth the powers of the sculptor and of the artist in color in addition to his practical knowledge of the manipulation and handling of skins. A group may be months or even years in the making but the final result is well worth the effort, for it is true to life, it is permanent, and it tells a story in a manner that can be appreciated by every one





THE BEAVER GROUP

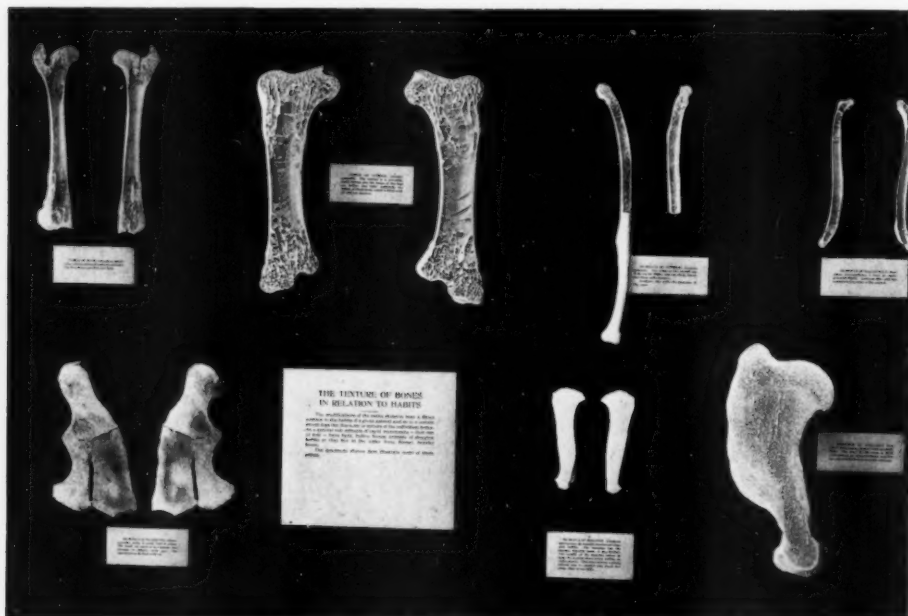
Most of the accessory material used in this exhibit is the actual wood and debris from a Colorado beaver dam. In the background skillful joining of actual objects with painted images secures the desired effect of realism

animals of great popular interest. The new southeast wing, now under construction, will house the hall of Asiatic and European mammals. Specimens for this exhibit have been brought together by different expeditions, the most important of which is the Third Asiatic Expedition, under the charge of Mr. Roy Chapman Andrews, now in the field. Considering the large scale upon which the Asiatic mammals are being collected, and the fact that the exhibits can be planned with reference to an absolutely new setting, the hall of Asiatic and European mammals, when completed, should be the finest thing of its kind.

played such a large part in the development of modern mammalogy.

In recognition of the value of the mammal exhibits to the serious-minded student as well as to the lay public, a hall has been given over to the story of mammalian evolution. This hall, known as synoptic hall, illustrates the category of mammals in their development from the lowest to the highest.

Beginning with the purchase of collections already formed, the department soon began to send its own expeditions into the field in the search for material, and so successful have these expeditions been that, largely through their activities,



This exhibit, showing the texture of bones in relation to habits, is one of many similar displays in the synoptic hall of mammals. This hall is frequently visited by classes in zoölogy and evolution

Upon the death in August, 1921, of the department's first curator, Dr. Joel Asaph Allen, the trustees of the American Museum dedicated to his memory the hall of North American mammals, the oldest and best-known of the exhibition halls. This hall is now known as the Allen hall of North American mammals, in honor of the man whose activities

the mammal collection aggregates today about 50,000 specimens. Lack of space forbids the listing in detail of the many and important expeditions which have gone out from the department of mammals. Furthermore, the greater number of these have already been tabulated in the columns of *NATURAL HISTORY*¹ by

¹July-August issue, pp. 311-13.



To keep the large collection of mammal skins and skeletons where they will be secure from insect attack or the fading agency of the sunlight, a great number of storage units are needed. These are installed in the different rooms of the mammal department, but the collections have outgrown the space within the department and a long row of cases filled with skins is temporarily placed along the main hallway of the fifth floor

Dr. Frank M. Chapman, for nearly all of the expeditions which were sent out to obtain birds were charged also with the collecting of mammals.

The first organized expedition was that sent out for bison in 1886, under Dr. D. G. Elliot and Mr. Jenness Richardson.

Later, parties combed western North America for other mammals, the fields of research extending from Alaska to Mexico. Arctic America contributed her share when Captain Comer in 1902, and subsequently Admiral Peary, brought back many northern species.

Mr. Roy Chapman Andrews made a number of trips for cetaceans and amassed material for the proposed hall of marine mammals, and later, turning to the Orient, made trips to Korea, Thibet, China, and other parts of Asia in search of mammals for the Asiatic hall. Many hundreds of specimens gathered on these expeditions have enriched the study collections of the department. Work was carried on in South America and the West Indies. In Ecuador, Mr. H. E. Anthony collected large series of mammals as well as in Panama, Porto Rico, Cuba, and Jamaica. The finest of all the mammal collections was made in Africa, under Mr. Herbert Lang, who brought back a vast amount of mammalian material after six years spent in the field. Expeditions of the department in the field to-day include the Third Asiatic

Expedition, two collectors in Ecuador, and an expedition in Australia. Furthermore, an important expedition is about to leave for India.

The numerous field expeditions have provided the research material for many scientific papers and reports. Dr. Allen was indefatigable in his study of the mammals obtained and published many volumes based upon them.¹ The more noteworthy of these publications from the department of mammals are, by Doctor Allen, numerous studies of South American mammals, "Review of the South American Sciuridæ," "Ontogenetic and Other Variations in Musk Oxen," "Mammalia of Southern Patagonia," many papers on North American mam-

¹For a detailed list of the writings of Doctor Allen, up to 1916, see *Autobiographical Notes and a Bibliography of the Scientific Publications of Joel Asaph Allen*, published by the American Museum of Natural History in 1916.



A section of the Jack rabbit group is shown to demonstrate how fidelity to actual living environment is secured. All of the brush, the grass, the flowers, and even the pebbles and earth for this group were taken up from an area the size of the group, at the locality where the rabbits were collected, were treated by the preparator, and used in the composition of the exhibit



The polar bear group

mals, and some long and very important works based upon African mammals; by Mr. Andrews, monographs on the cetaceans; by Mr. Anthony, papers on mammals from western North America, from South America, from the West Indies and *The Indigenous Land Mammals of Porto Rico, Living and Extinct*; and by Mr. Lang, papers based upon his collections made in Africa.

The care of the study collections has entailed no little trouble, expense, and thought. When the series was small, the problem appeared to be solved by storage in the so-called "Cambridge cans." With the growth of the collections such facilities were no longer adequate, and the difficulties which accompany expansion were insistently manifest. The installation of large, steel, insect-proof storage units has been under way for several years, and the eventual housing of the entire study series of skins and osteological material in such units will be a long stride in the right direction.

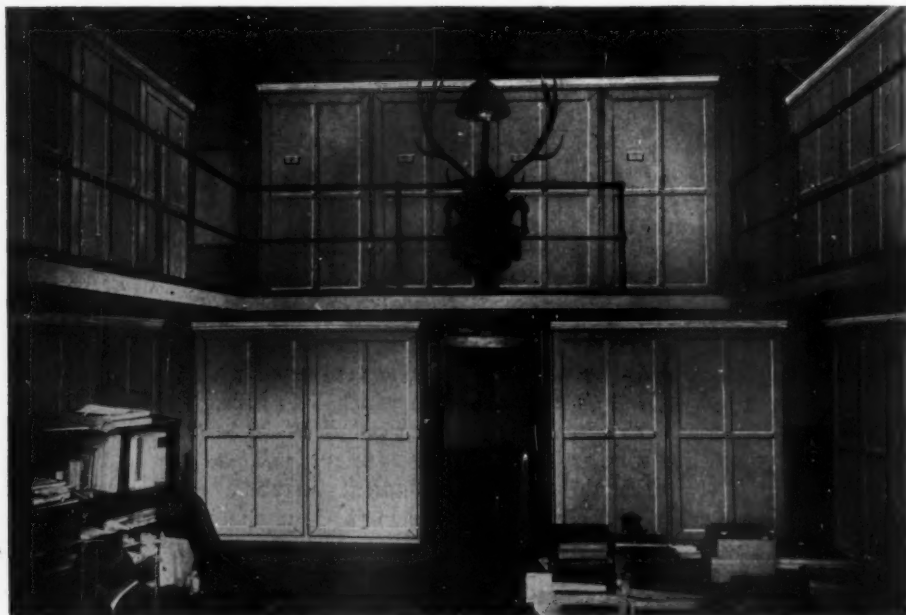
A few additional items to indicate the

scope of the work in the department will be touched upon briefly here. Card catalogues of all publications upon mammals are kept up to date, the sum total of such cards being many thousands. The collections are being card-catalogued as well, a card for every specimen, in order that there may be a complete and condensed record of everything in the collections. Maps are made, often of regions inadequately represented before, and the best cartographer obtainable is employed, because the department finds that particular geographical areas in which it is interested have not been worked up by the geographers. Lectures on various subjects are given by the different members of the department: some of these are based upon explorations, others present the results of scientific research and are given before scientific societies. Specimens are loaned to, borrowed from, or exchanged with other scientific institutions, material is identified and named whenever it is sent in for that purpose, and numerous written inquiries upon many subjects

must be answered. Scientific research occupies all of the energies of the department when the personnel is not engaged upon exhibition plans, the preparation of popular accounts or lectures, or routine matters, and so many are the interesting problems in mammalogy waiting to be solved, that the mammalogist often regrets that the day contains so few working hours and is apt to spend his annual vacation in the way that gives him the keenest pleasure he knows of, namely, the pursuit of his pet piece of research. The major problems now before the department of mammals are the distribution, the relationships, and the habits of the mammals of Asia, the mammals of the Belgian Congo, and the mammals of Ecuador, and the fauna of the West Indies and the light it throws on the origin of these islands. A year has just been spent in investigating the fur

trade as the principal factor in the threatened extermination of many of the world's mammals.

This short article has outlined the more obvious steps in the growth of the department of mammals and has drawn attention to a few of the functions that the personnel are called upon to perform. The progress achieved by the department, from the time it began and Dr. Allen entered the first data in the department catalogues, up to the present, when it requires the greater part of the time of two assistants merely to care for the collections, has been considerable, but the promise of the immediate future is such that the development of the department need not lag. In fact, with increased opportunities, the department should to an even greater extent justify its existence to layman and scientist on economic, æsthetic, and didactic grounds.



Research and study is carried on in the offices and laboratories on the fifth floor, where the great bulk of the mammal collection is stored and where the material for examination is kept close at hand



Photograph by Ira A. Williams

The perfect conical form of Mount St. Helens is a wonderful example of a volcano that ceased eruption less than a hundred years ago. There is a crater in its top and several glaciers cling about its slopes. The mountain rises above the enclosing forest as a conspicuous landmark that has served to guide the path of explorers from the time of Lewis and Clark's first expedition and the early operations of the Hudson Bay Company to the present

TREE CASTS IN RECENT LAVA

OBSERVATIONS MADE NEAR MOUNT ST. HELENS, WASHINGTON

BY

IRA A. WILLIAMS*

WHEN it is stated as a historical fact that Mount St. Helens, a volcanic peak in southwestern Washington, was in eruption repeatedly up to 1842, we are not surprised to find upon its slopes and in the country round about its base many of the interesting phenomena which usually accompany the forceful ejection of large quantities of liquid lavas.

St. Helens rises to an altitude of 9671 feet as a great white cone visible in all directions for many miles. It is located well down the west slope of the main Cascade Range of mountains in the forest belt of western Washington. Although glaciers still exist upon it, its almost perfect conical outline is doubtless due to the fact that these ice-streams have not gouged or marred to any ex-

tent the higher parts, the graceful lines of which are still those given to it largely by the falls of ash and cinders and scoria that resulted from the final more violent paroxysms of eruptive effort.

About the base of this mountain liquid lavas broke out in the past at many points. In response to the pull of gravity these flows settled into the lowest portions of the surrounding land surface, which were then, as now, the radiating stream cañons of the region. Down several of these cañons the molten lavas flowed for many miles, filling them up and diverting the streams which occupied them—in instances, damming side-streams so as to form swamps or lakes of their waters.

Forest growth encroached upon this actively erupting volcano. Indeed, long

*Geologist, Oregon Bureau of Mines and Geology



Photograph by Ira A. Williams

The original forest growth closely fringes the borders of the lava field and, as the beginnings of soil formation permit, vegetation gains a foothold on even the rough lava surface itself

before it settled into a state of quiescence, it was surrounded by one of the most luxuriant stands of fir timber in the entire Northwest. Its later flows, therefore, in their progress down its lower slopes met and overwhelmed portions of the upper fringes of this forest mantle. Today heavy stands of trees come to the very edge of rough and barren lava fields, although, when the lava flow occurred, it consumed with heat or inundated all the vegetable life that was in its path. In age these new lava fields vary from a state of youth so fresh that a scant bit of clinging moss or lichen is the only evidence of plant life, to surfaces on which, though as yet showing only the merest beginnings of soil formation, scattered evergreens of fair size have gained a precarious foothold.

The Kalama River, which heads upon the southwest slope of Mount St. Helens, is one of the larger of several streams that receive their water largely from the melting snows of this Fujiyama of the Pacific Coast. The character of the up-

per portions of the cañon of this river has been much altered and, in fact, determined mostly by glacial action and successive flows of lava, which have shifted the course of its waters repeatedly. One of the last of the lava flows found its way down the cañon of the Kalama River to a point approximately twelve miles in a line due southwest from the summit of the mountain. In its progress to this point a heavy forest growth was apparently overcome and swept away. Some evidence as to the manner in which the large trees of such a forest were destroyed is illustrated by the accompanying photographs.

The views are of portions of the lava surface taken near the border of the Kalama flow, in about Sec. 7, of Twp. 7 N. R. 4 E., Cowlitz County, Washington. The broken lava is here covered to some extent by a growth of grasses and shrubs and a sparse stand of forest trees. These trees tell us that, although the flow is so little obscured that every swirl of lava current can be seen, a hundred years and

more have doubtless elapsed since the lava came to rest and solidified where we now find it. The surface of the flow is an uneven one. There are the pits and pressure domes and ridges, the hummocks of broken angular blocks, the corrugations, all of which are the outward expression of the strains to which the hot viscous mass was subjected in coming to a final position of rest.

In places circular holes appear in the surface of the lava. Some are horizontal, some vertical. On exploration these prove to be the casts of tree trunks in the solid rock. The "tree tunnel" shown in the photograph below has a bore four feet across and may be entered for a distance of from thirty-five to forty feet. In the center, above this "portal," the flat-lying twig indicates the position and diameter of a still larger "tree well." This well is from four to four and a half feet in diameter, round, and quite open throughout its full depth of thirty feet or so. In its bottom, which is also the base of the lava flow and the old soil on which the tree grew, one may catch the glint and

hear the ripple of running water; thus, literally, as well as figuratively, a well in the ordinary sense of the term.

A fact of interest is that at a few feet below its top a small opening connects the tree well with the tree tunnel and admits a shaft of light the reflection of which is but dimly discernible in the photograph. The inference is inescapable that here the moving lava surrounded a gigantic growing forest tree which, though in all probability quickly consumed, did withstand the fiery onset for a sufficient space of time to congeal about it a casement of such thickness and rigidity as to indicate to us today its former size and position. The top portion of perhaps this same tree or of another of equal or even larger proportions was toppled over. Its weight was great enough to cause it to sink slowly into the viscous lava, by which it was completely covered. While the forward motion of the thickening magma must have been slight at this time, such movement as there was could have floated this log along until it met the upright tree or incasement al-



Photograph by Ira A. Williams

A tree tunnel in the lava that has a diameter of four feet and may be entered for a distance of from thirty-five to forty feet

IMPRESS LEFT BY A CON- SUMED GIANT OF THE FOREST

The impression of a large tree in the solid lava, produced by the impact of the fall of the tree and the pressure of its weight while recumbent. At the left a single ring of lava (seen more clearly in the picture on the opposing page) surrounds the opening, and still beyond is a short length of "tunnel" with daylight showing through. The tree was from four to five feet in diameter if one may judge by the dimensions of the shell it has left. The narrow ring, or arch, may be either a remnant of the collapsed roof shell that, at the time of the lava flow, covered the log entirely; or, as likely, the still intact bridge that was formed when a viscid tongue of the stiffly flowing mass was pushed across the prostrate tree till it found support at the downstream side. (Photograph by Ira A. Williams)



CLOSER VIEW OF THE SAME
TREE CAST

In this picture the space intervening between the encircling ring of lava and the short tunnel beyond is more clearly indicated than in the opposing photograph. There is probably evidence in the series of joint blocks that form the left abutment of this ring, or span, of the more sudden hardening of the lava in contact with the tree, even though in the consumption of the substance of the tree considerable heat must, momentarily, have been produced. Evidence of actual contact of the liquid lava with the scorched surface of the burning tree is to be seen in nearly every one of many tree casts. At the right of the person in the view the polygonal markings are the expression in the now solid rock of the charred surface of the wood when the soft lava first took shape around it. (Photograph by Ira A. Williams)



ready formed about it, there to come to rest and in turn suffer ultimate cremation. Its disappearance left the conspicuous annular opening which arouses our wondering interest today.

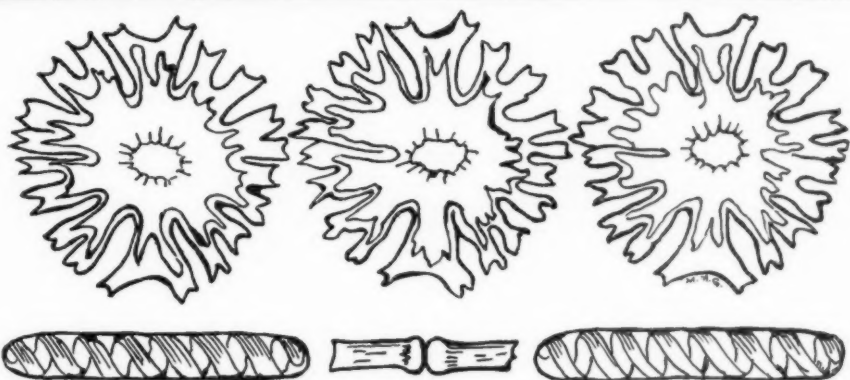
It is not easy to visualize the exact events attending the submergence and destruction of a forest growth by the forward and spreading movement of a body of highly heated, liquid lava. On its approach all shrubbery and smaller trees would certainly first be withered, then completely burned, in advance of actual contact with the molten lava. Only large trees would stand until surrounded by the scathing deluge and these doubtless would be seared from base to top before their undermining was completed and resulted in their fall. Though

wood impressions are plentiful, none of the bark of a tree has been observed. It would seem that the ready combustibility of the bark and of the smaller branches doubtless accounts for the universal absence of their imprints. They were entirely burned away while the tree was yet upright, or so quickly following its fall that preservation of their markings was never accomplished. Indeed, only a favorable consistency of the lava after forward movement had practically ceased, and a temperature near the solidifying point, could effect, first of all the forming of the tree casts themselves and, in the second place, though much less frequently, the taking of the imprint of the burning wood and its indelible retention in a wall of the lava as we see it today.



Photograph by Ira A. Williams

Close view of the wood impressions noted in the preceding photograph. These are not the stamp of the bark of a tree but are a replica in reverse of the characteristic surface features of wood that has been not merely seared but deeply burned and changed to charcoal



NATURE STUDY WITH THE MICROSCOPE

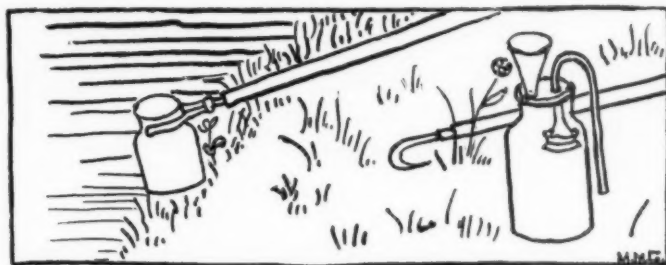
BY
PHILIP O. GRAVELLE

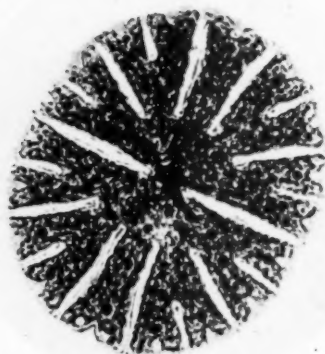
THE interest shown in various branches of nature study, with the constant accessions to the ranks of nature lovers, should lead us to consider the advantages placed at our disposal by the use of the microscope. Those who are fortunate enough to possess such an instrument appreciate the extensive field open to them and are gaining a finer insight into the wonders of nature. They can correlate their observations with those of others and with persistence may even happen upon hitherto unknown stages in the life history of the organisms under examination.

The nature student of today hunts with binoculars and camera instead of with trap and gun. Moreover, it is only a limited part of the living world that

reveals itself to the unaided eye. In botany and zoölogy a long scale exists in which plants and animals diminish in size, until we can no longer recognize their form or functions without the assistance of optical instruments.

Our first aid is the hand lens or simple microscope, which magnifies up to eight or ten diameters. Beyond this the compound microscope is necessary to show structure and detail in a better manner. How much in our environment of which we are ordinarily unaware can be made manifest through the microscope and how interesting are the details of structure of some of the smaller creatures with which we are familiar, are indicated in the illustrations that follow.

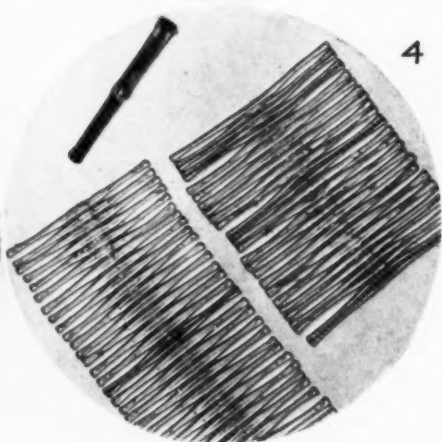




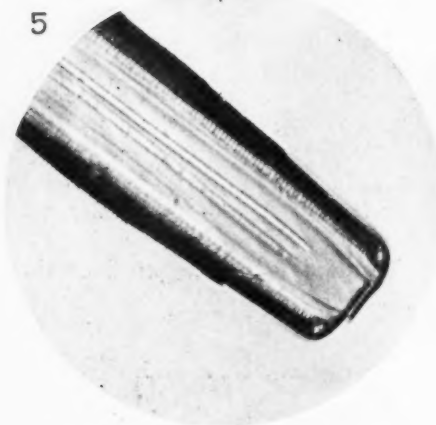
3



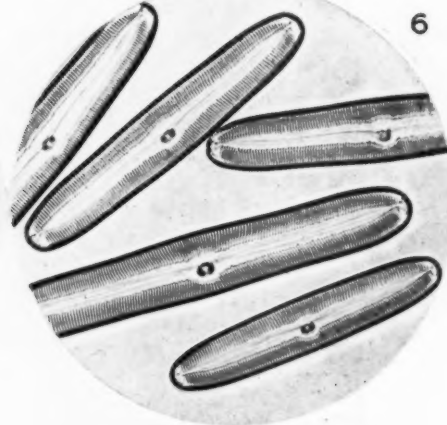
4



5

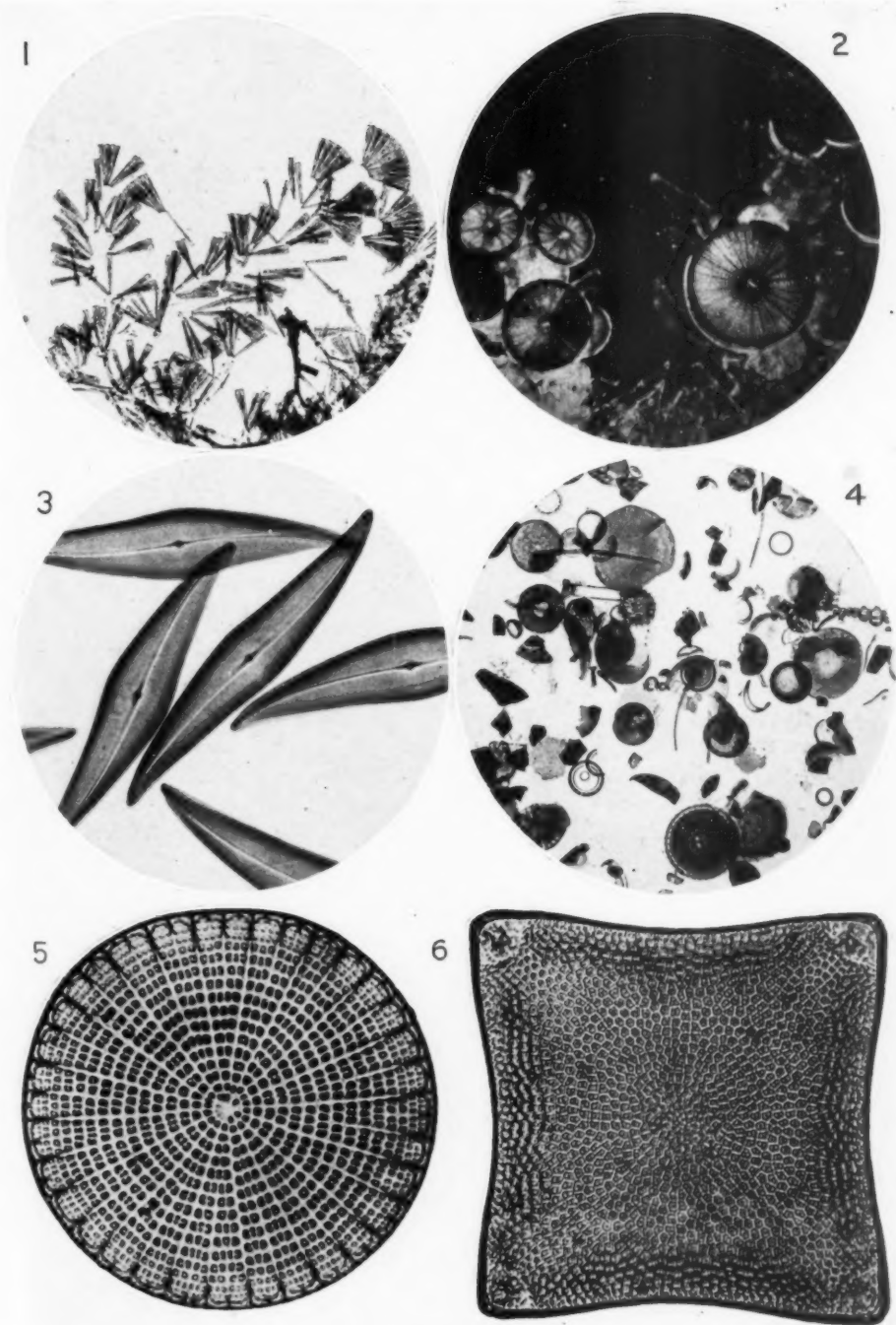


6



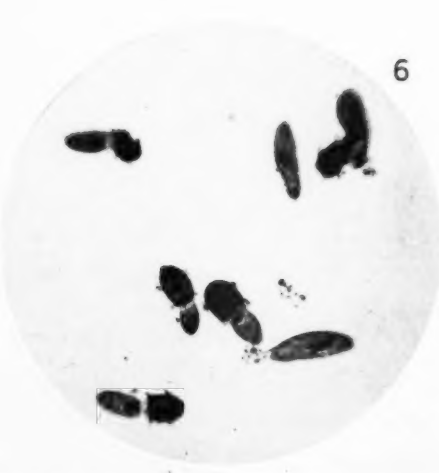
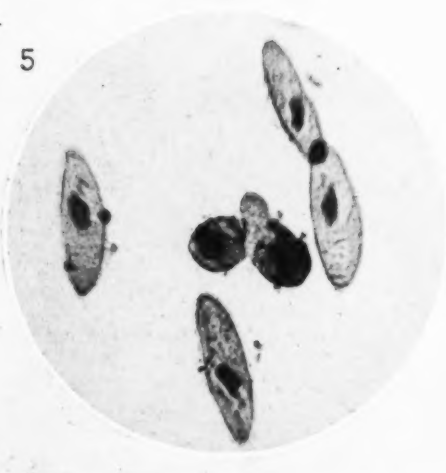
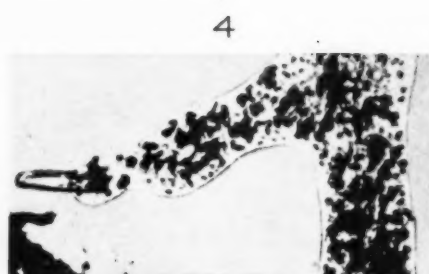
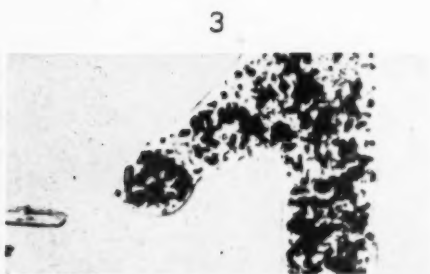
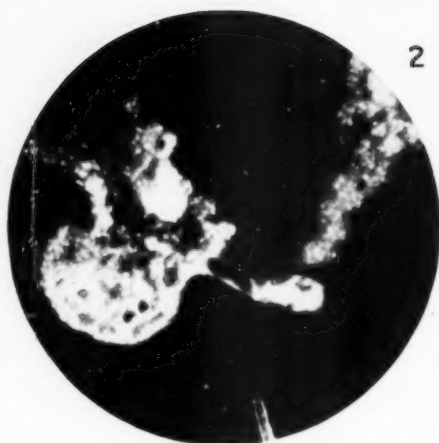
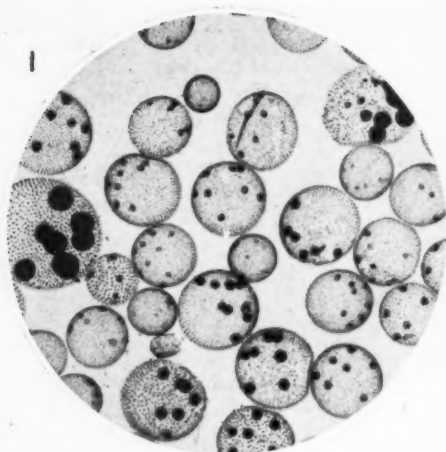
FRESH-WATER MICROSCOPIC PLANTS

(1) Sometimes the surface of pools is covered with what looks like a floating green scum. Examined through the microscope it may prove to be an alga called *Spirogyra*, which is composed of threadlike filaments of single cells placed end to end, containing a spiral network of green chlorophyll bands. (2) Patches of green on the bottom of the pool may be desmids like the one shown, a *Micrasterias*. (3) In moist places are found the diatoms known as *Synedra superba* attached like miniature needles to larger aquatic plants. (4) *Synedra* are found also joined together in raftlike groups or floating unattached. (5) The diatoms unlike the desmids have the power of extracting silica from the water to form double flinty coverings which shut together like a pill box. One half of a *Pinnularia* is here shown. (6) The *Pinnularia* move backward and forward like miniature submarines. For their size they show considerable power, for they push aside debris much larger than themselves.



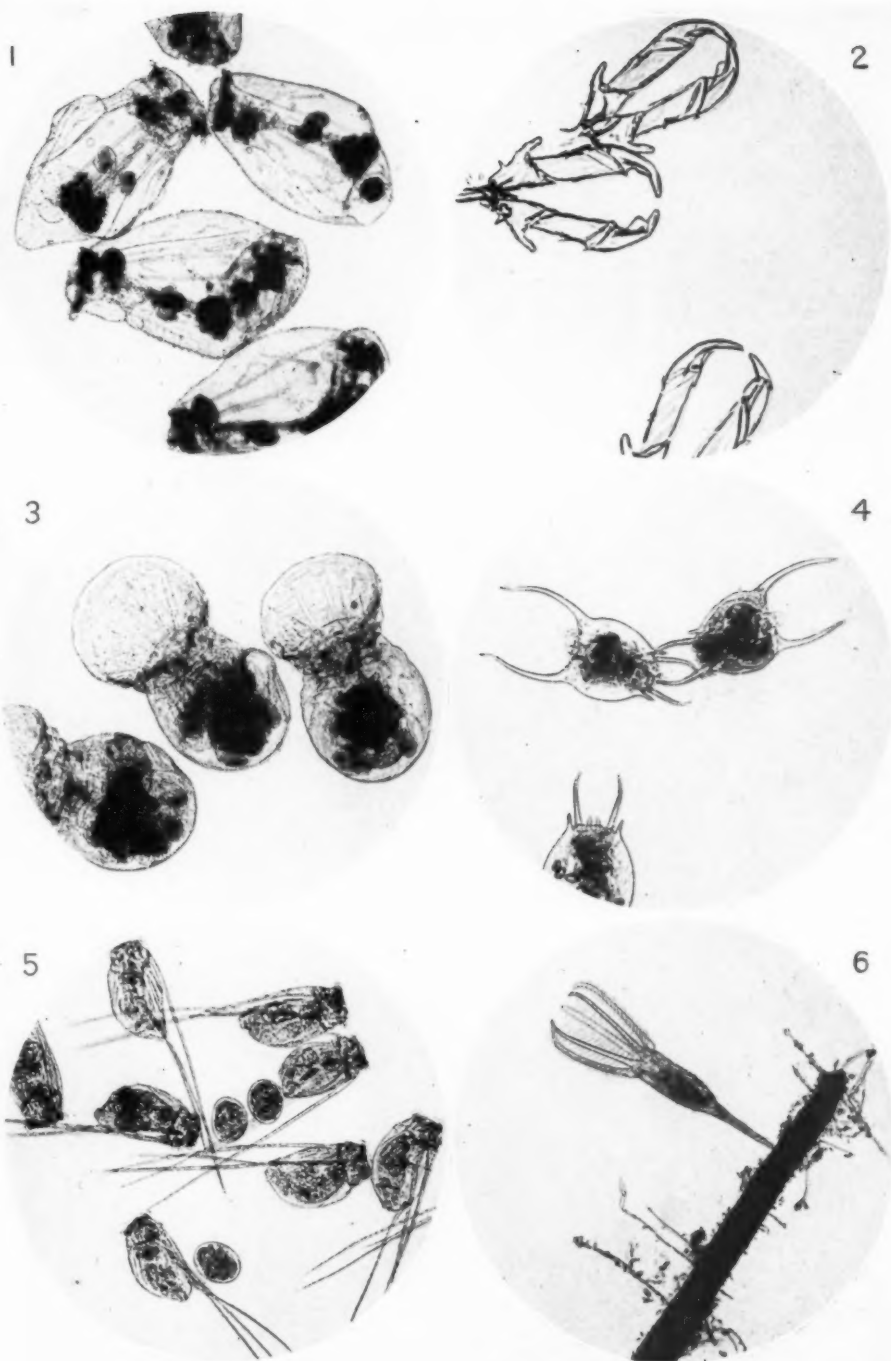
MARINE MICROSCOPIC PLANTS

(1) The diatoms are among the most widely distributed of unicellular aquatic plants, there being both marine and fresh-water species. Some like *Licmophora splendida*, here shown magnified 35 times, grow attached to plants in fan-shaped colonies. (2) Other diatoms, like *Arachnoidiscus*, dot the seaweeds as engraved disks, their wonderful markings revealed only by the higher powers of the microscope. (3) An unattached or free-swimming diatom is *Pseudosigma angulatum*, of varying shape and sculptured surfaces. The magnification is 213. (4) The photograph shows a strewn slide made from the core of an artesian well drill, at Brigantine, New Jersey. The fossil marine diatoms depicted were taken at a depth of 500 to 600 feet. (5)-(6) In Sendai, Japan, a deposit of diatomaceous earth occurs, well known on account of the beautiful fossil diatoms found therein. Two of these diatoms are here shown, *Arachnoidiscus indicus* (5) and *Trigonium arcticum* (6)



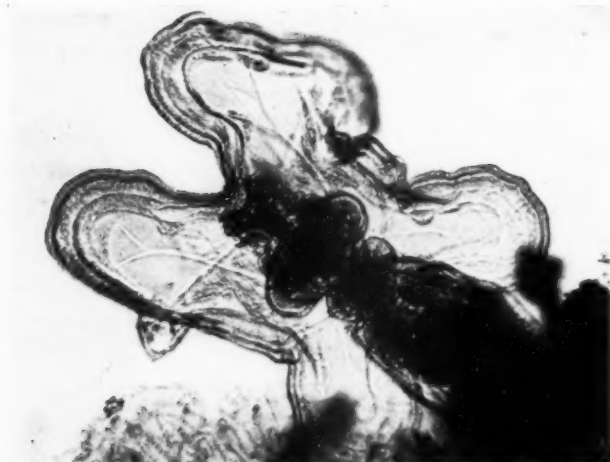
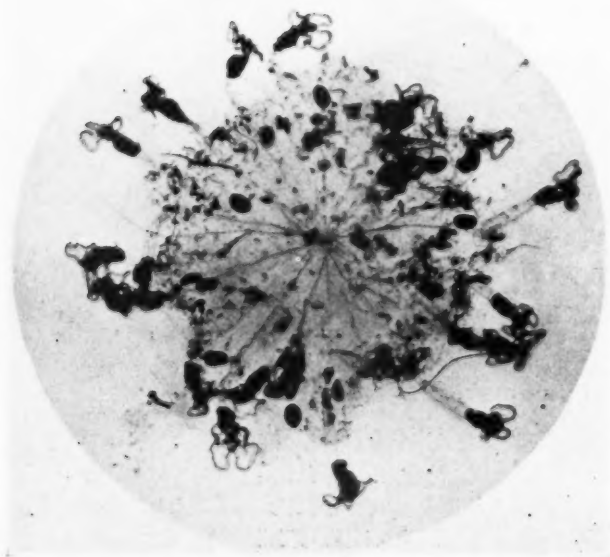
SOME PROTOZOANS OF OUR PONDS

(1) During the summer months ponds may appear green in color due to the large numbers of the organism, *Volvox globator*. These tiny globules, in reality about the size of a pinhead, revolve gracefully, the rolling motion being caused by the vibration of fine hairs or cilia covering the globe. The dark markings are smaller spheres in process of development within the parent spheres. (2) This is a dark-field photograph taken from a motion-picture film of *Amaba proteus*. The organism multiplies by simple division, two animals taking the place of one. In (3) and (4) another phase of the activities of *Amaba proteus* is shown. In (3) the *Amaba* is extending a pseudopodium toward a diatom floating conveniently near. In (4) the pseudopodium has been further elongated and is surrounding the diatom. In (5) two cup-shaped animals, *Didinium*, are engaged in consuming jointly a single *Paramecium*, neglecting the free-swimming prey that is temptingly near. In (6) there is a better distribution of effort, each *Didinium* having taken exclusive possession of a *Paramecium*. The magnification in (5) is 86 diameters, that in (6) is 54.



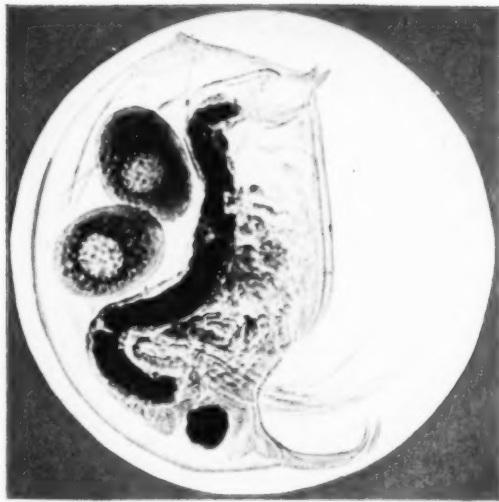
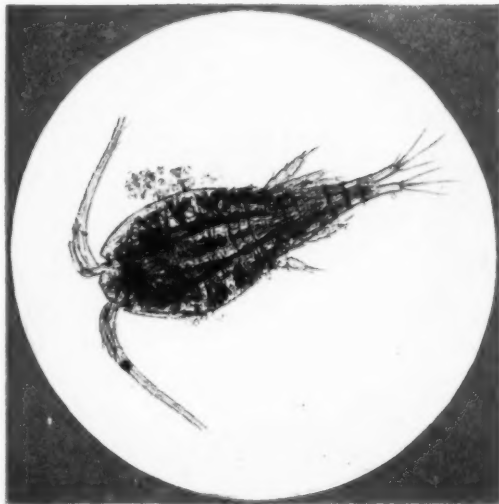
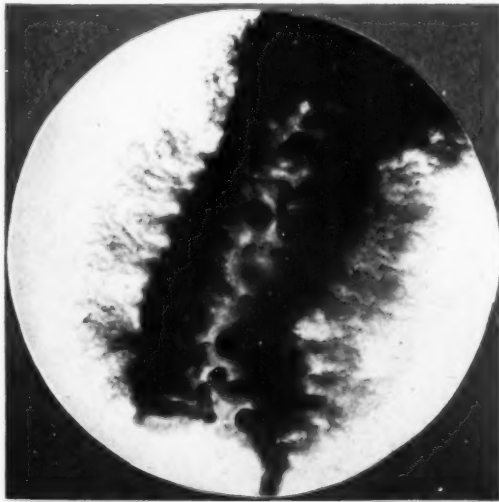
ROTIFERS FOUND IN FRESH-WATER PONDS

(1) A group of rotifers, *Asplanchna silvestrii*, from Devil's Lake, North Dakota. Through the transparent body can be seen the various organs. (2) One of these organs, the mastax, is furnished with chitinous jaws, which are used in preparing food for digestion. Three pairs of these jaws, detached from three rotifers, are shown in this picture. It is the possession of such jaws that distinguishes the rotifer from all other microscopic animals. The magnification is 186. (3)-(4)-(5) Great variation in the shape of free-swimming rotifers is here shown. The figures represent respectively *Apsilus vorax* (magnification 60), *Brachionus falcatus* (magnification 75), and *Triarthra longisetia* (magnification 90.) (6) It is the ambition of every student of microscopic life to find the crown animalcule, *Stephanoceros eichhorni*. This rotifer is about one-fiftieth of an inch in length and is fitted with a crown of five spreading arms, fringed with hairs or cilia in rapid motion. These create a vortex in the water whereby food is brought to the animal's mouth. All of the illustrations shown on this page are made from photographs of specimens in the American Museum



A ROTIFER IN ACTION

Three pictures of the rotifer, *Octotrocha speciosa*. During the early summer months this rotifer dwells in colonies upon submerged leaves. If one of these leaves be taken from the water and examined with a good hand lens, little globules of a jelly-like substance may be seen. Watching one of these closely, one detects a show of animation within the gelatinous matrix. The individuals of the colony—for that is what the globule consists of—are extending beyond their transparent abode, unfolding like the petals of a flower, yet without losing contact with the jelly mass, for the footstalk of each individual has anchorage in the common center. The picture on the left shows a colony; those at the center and right successive views of an individual unfolded, with its cilia in rapid vibration, thereby causing food particles to stream toward the mouth. Within the animal can be seen the working jaws. The pictures at the center and right are reproduced from motion-picture photographs of living specimens

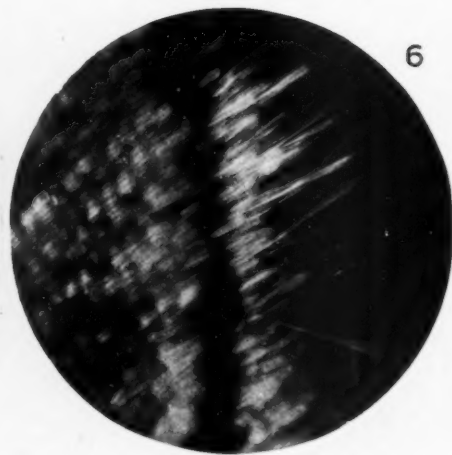
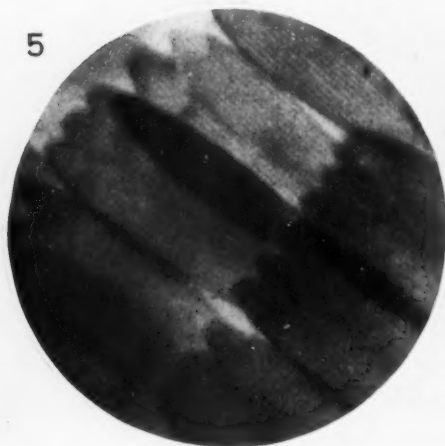
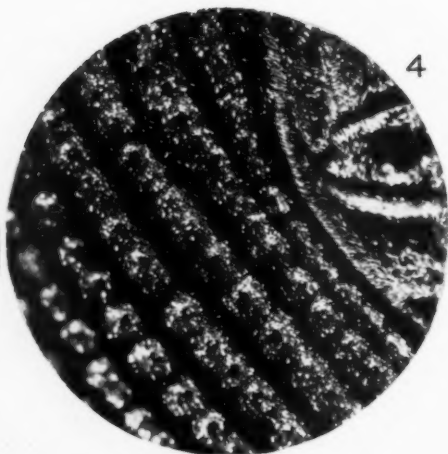
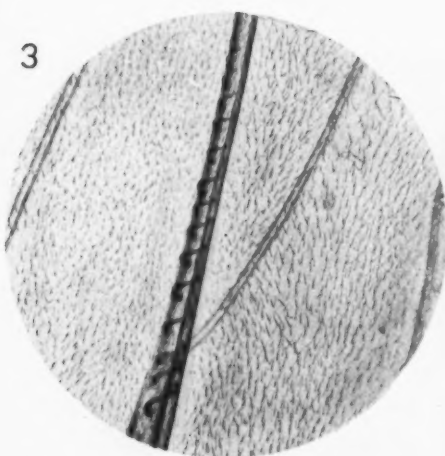
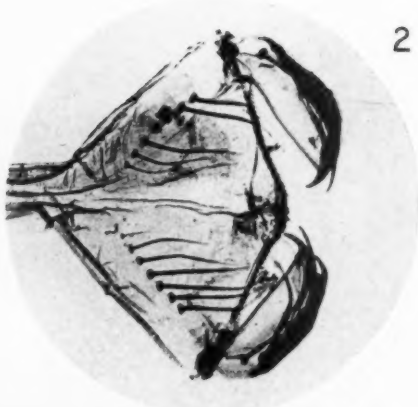


OTHER CREATURES THAT REPAY STUDY

Another group of animals living in colonies are the Polyzoa. *Cristatella*, shown on the left, is unique among the Polyzoa in that the whole colony can move about of its own accord. The colony, of which a portion only is seen here, is united into a body of oval shape, rounded above and flattened below, adhering by means of the under surface. The colonies, from one half to two inches in length and about one eighth of an inch wide, are found in shallow water with tentacles thrust out and shining in the sunlight. The magnification is 9.

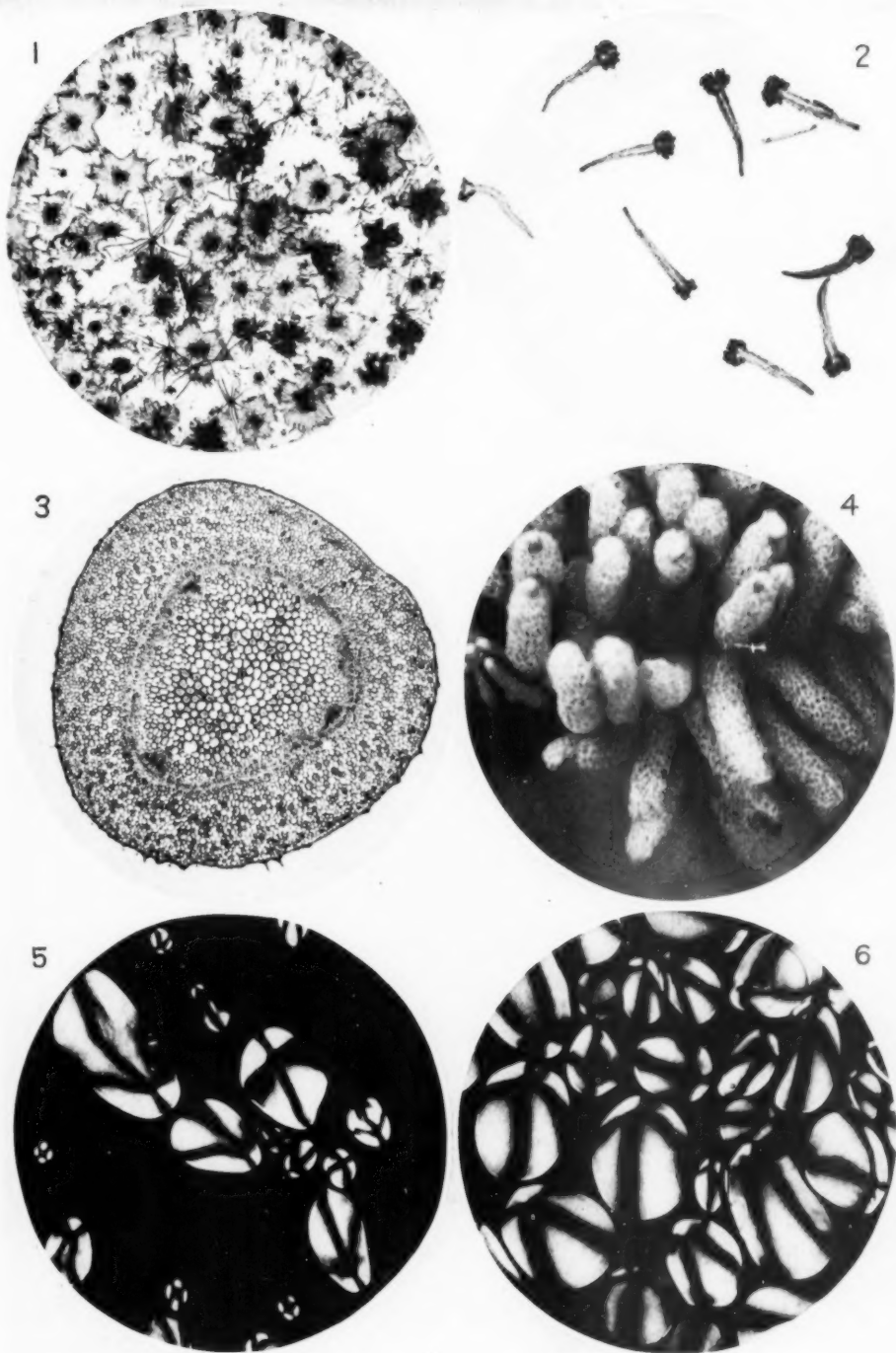
The other two pictures are of crustaceans. That in the center represents a common cyclops, with a single eye in the middle of its head. The creature, though microscopic in size, is not inapparently named after the one-eyed giants of Greek mythology. Attached to its body is another organism, *Carchesium*, a protozoan parasitic upon the cyclops.

The water flea, *Bosmina longirostris*, magnified 140 times, is shown on the right. Needless to say, it is not a true flea, but the way it jumps about in the water suggests the mode of progress of a flea. The transparency of this crustacean reveals every detail of the creature's structure. Note the two eggs within the body



MINUTE PARTS OF INSECTS

(1)-(2) The young of the dragon fly, unlike their swift-flying parents, are sluggish creatures. They live in water and lie in wait for their prey. As this approaches, the young dragon fly shoots out from its mouth its jointed lower lip, armed with pincers for gripping the victim. These pincers, enlarged 34 diameters, are shown in (2). (3) The hooks and grooves connecting the front and rear wings of a wasp. These wings operate as one when the insect is flying. (4) Side markings on the Brazilian diamond beetle. The pitted surface of this beetle is richly sprinkled with brilliant greenish gold scales, which sparkle like diamond dust. (5) Scales on the wing of a butterfly. Magnification, 370 diameters. (6) This picture shows the scales along the edge of the wing, which differ from the inner scales. Even the inner scales present differences in various portions of the wing, notably so in the male of certain species.



DETAILS OF PLANT LIFE REVEALED

(1) Epidermal organs of the buffalo berry, *Shepherdia* or *Lepargyrea*. Magnified 15 diameters. (2) The spines of the strawberry, 8 times their natural size. These miniature carpet tacks may account for the uncomfortable irritation complained of by some people after eating the berries. (3) A cross section of the stem of a geranium, showing the arrangement of the cells. The photograph is 9 times the size of the original. (4) Fungi, too, may be made the subject of microscopic study. The fungus here shown belongs to the Myxomycetes, or slime molds, formerly regarded as animals, Mycetozoa. This fungus is usually found in damp woods, attached to dead stumps or the dead branches of trees. (5) The starch of the potato under polarized light. This starch has a characteristic oyster-like shape different in outline from the starch taken from the root of the canna, which is shown in (6). The magnification in each case is 200 diameters.



THE WORSHIP OF THE CEDAR TREE

This tree, which had been cut down some days before the ceremonies described in this article took place, was erected in the open plain. Prayers and songs were addressed to it, tobacco smoke was blown upon it, and the ashes of the pipe were sprinkled over it and deposited at its base

INDIAN CEREMONIES OF THE LONG AGO

A REVIVAL BY THE ARIKARA OF NORTH DAKOTA OF SOME OF THEIR
ANCIENT, DISUSED RITES

BY

PLINY E. GODDARD*

CLASSIFIED according to their ways of living, there were formerly on the Great Plains two fairly distinct groups of Indians. To the public of today the more familiar of the two are the buffalo-hunting, nomadic tribes that practised no agriculture. In this group are the Teton Dakota, the Arapaho, the Cheyenne, the Crow, the Blackfoot, the Kiowa, and others. They were prominent forty years ago because of their war activities, particularly the Dakota, led by Sitting Bull. When the buffalo disappeared, these nomadic tribes were forced to engage in new activities.

The second group of this general region was composed of the Mandan, now practically extinct, the Hidatsa, and the Arikara on the upper Missouri, the Pawnee and Omaha formerly in Nebraska, the Iowa, the Kansas, and Osage in the east and south. In contrast to the members of the first group these tribes were sedentary, living in fairly permanent villages, and practised agriculture. It is true they also hunted buffalo and some of them lived during the winter in skin tipis as did the tribes of the first group.

In the first half of the nineteenth century they were well known to the reading public. Lewis and Clark spent the winter of 1804-5 among the Mandan. In 1833 the villages of the Missouri were visited by Maximilian, Prince of Wied, who published a beautifully illustrated account of his journey. George Catlin, who was with them about the same time, brought them to the attention of the public through his writings and his pictures. He made a number of studies in oil, uniform in size, which were shown in Europe and America. Many of his originals were presented to the American Museum by Mr. Ogden Mills.

Except for a short flurry over Mandan corn during the war, concerning which an article appeared in *NATURAL HISTORY*,¹ little attention has in recent years been paid to these tribes, reduced as they are in numbers. The Mandan long ago discontinued the Okipa ceremony, Catlin's account of which was thought at first exaggerated and sensational. The public ceremonies of the neighboring tribes, the Hidatsa and Arikara, were also discontinued at the insistence of the Indian Department.

Sometime last year the Arikara approached Dr. Melvin R. Gilmore, of the North Dakota State Historical Society, with the request that he secure permission for them to hold their ceremonies so that a full record of these rites might be made. In carrying out this request Dr. Gilmore, who wished the work done with all possible care, sought the aid of the department of anthropology of the American Museum.

Formerly these agricultural, sedentary Arikara had their dwellings, which were earth-covered houses, grouped closely together in villages. In the middle was a large lodge of the same general structure, which served as the religious and social center. At the present time the Arikara are living in small farm houses scattered over the prairie on either side of the Missouri. They have no villages and no earth-lodges in which an old ceremony could properly be given. They have, however, modernized buildings, one on each side of the river, in which dances and social gatherings are held.

At first the Indians contemplated building a regular earth-lodge, that the

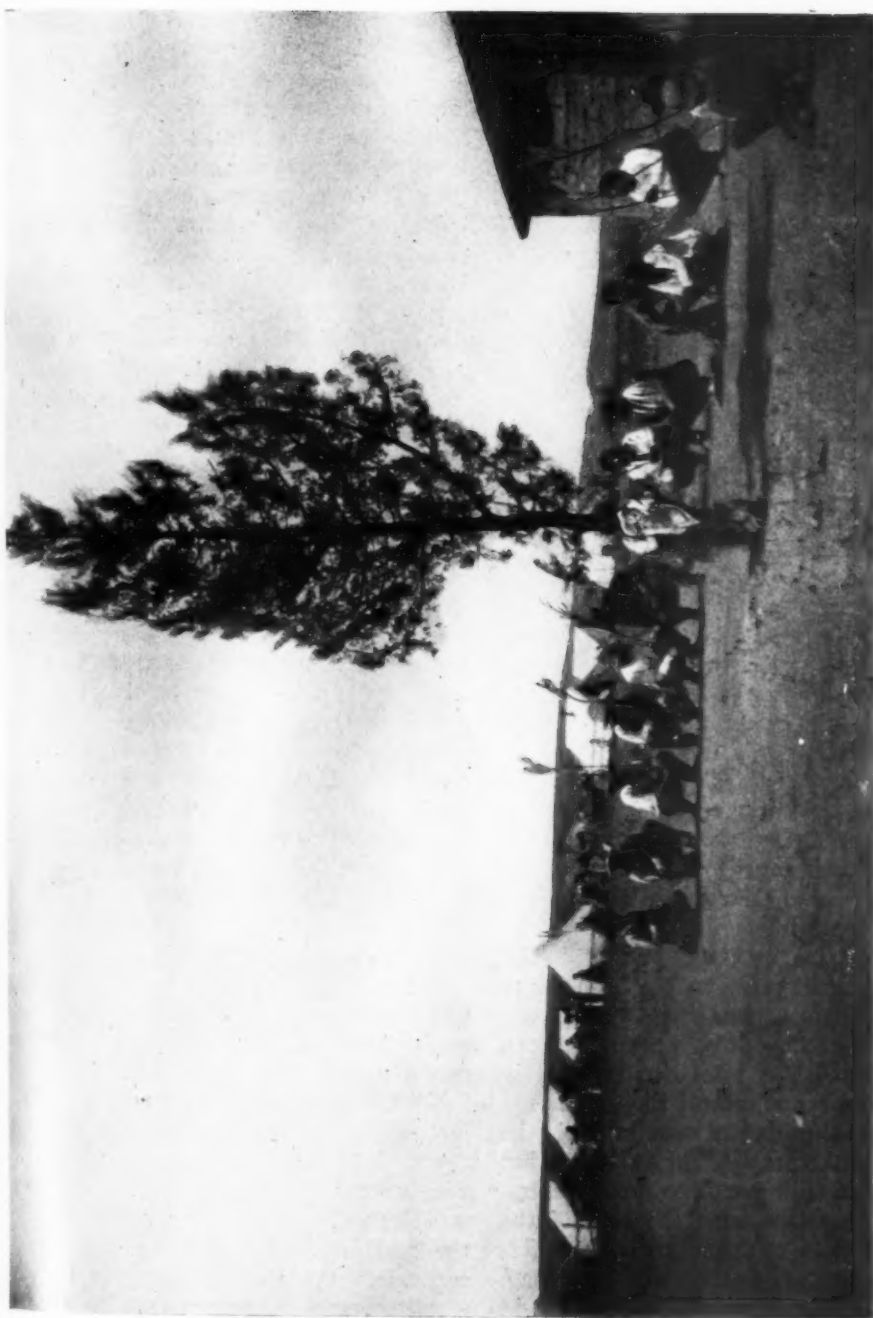
¹"Indian Corn as a World Food." By Clark Wissler. *NATURAL HISTORY*, Vol. XVIII, Number 1, pp. 25-9.

*Curator of Ethnology, American Museum.



ONE OF THE MEDICINE SOCIETIES GREETING THE CEDAR TREE

After the tree had been removed from the spot where it had been placed originally (see frontispiece) and erected close to the lodge, or community house, the various medicine societies successively issued from that building in order to visit the tree and to dance, sing, and play



THE MEAT OFFERING

The worshippers are holding willow sticks to which have been tied bits of meat. Prayers were said first in the community house, and then before the tree. At the conclusion of these rites, the worshippers dashed off to deposit the willow sticks out in the prairie

ceremony might be perfect in its setting. However, time would not permit their doing so, for the grain harvest was not yet garnered and much wild hay had to be cut for the winter. Moreover, the community house on the left side of the river was in the general form of the earth-lodges and lent itself to the requirements of the ceremony.

The investigating party consisted of Dr. Melvin R. Gilmore, curator of the North Dakota Historical Society, Mr. George F. Will, of Bismarck, a local archaeologist and ethnologist; Miss Gladys A. Reichard, assistant in anthropology at Barnard College; and the writer, P. E. Goddard, curator of ethnology of the American Museum of Natural History.

On Sunday evening, August 14, 1921, we were met by the Arikara in council to consider plans. On Monday afternoon there was a preliminary assembly, during which an invocation was made to Mother Earth advising her of the intention to hold the ceremony. Songs were sung which narrated the creation of the earth and the early history of the Arikara tribe.

After a period devoted to ceremonial smoking, the various medicine societies, seated in order around the house, delivered their songs. The owls, for example, sang of the creation of that bird at the beginning of the world and of its continuing until the present day. The other societies mentioned in like manner their eponymic animals.

In the evening at 9:30 the sage dance was given. The older men, dressed in breechcloths and moccasins, knelt at the altar and then danced about a fire in the center of the house. They held bunches of sage in their hands to protect themselves somewhat from the heat of the fire. Because of the nature of the building the fire was not allowed to become very fierce. One could imagine that in earlier days, with many more participants and the men in better athletic condition, the dance must have been highly spectacular.

Tuesday morning the investigating party was invited to be present at the consecration of the cedar tree. This tree had been cut some days previously and placed on the open prairie three hundred or four hundred yards from the house. The priests sat in the grass near the tree and sang for some time, saying, "We are here, we have come for you." The tree was raised and the various priests standing before it in turn sang additional songs as they shook their rattles. Tobacco smoke was blown on the tree and finally the ashes from the pipe were sprinkled on it and placed at its base, where food also was deposited as an offering. The men who were officiating then ate food which was brought to them by attendants.

The tree was lowered again and carried to a position in front of the house door. Offerings of cloth were brought and piled on the tree, a priest blessing each donor by stroking and pressing motions with his hands. Especial care seemed to be taken that small children should participate in and receive the blessing.

The various societies came out of the community house in succession, danced, sang, and played, representing the animals for which they were named. The members of the bear society wore skins of that animal and chased the members of other societies about the space before the house.

The tree was later taken into the house and placed before the altar. The leader of the bear society went to it and pretended to eat of its branches. It was finally taken to a position reserved for it just in front of the door beside a small stone. Both tree and stone were adorned with wrappings of cloth, and the stone was also painted. This stone represents the male supernatural being and the cedar tree the mother earth, or holy grandmother. It appears that the tree and stone constitute the village or tribal shrine. The stone remains permanently, but the tree is replaced each June, the discarded one being sent down the Mis-

souri on the freshet to visit the older village sites.

In order to conclude the ceremony as soon as possible the early morning hours of August 17 were devoted to the preparation of a large bowl of cornmeal mush. The second ceremony, known as Mother Corn, began with the opening of a sacred bundle at 10 A.M. These bundles were mentioned by travelers who visited the Missouri early in the nineteenth century. We were present at the second ceremony and had the opportunity of handling the bundle contents and of asking questions. The main constituent objects were ears of corn, the skins of birds, and scalps. Among the skins was that of a parrakeet, a bird mentioned in Prince Maximilian's list as being on the Missouri, but now so long extinct that the Indians remember it but vaguely. The bundles are handed down from father to son and ordinarily the rituals, consisting of songs, prayers, and myths, are passed along with the bundles themselves. Other Indians than the bundle-guardians often know the ritual. Unfortunately, the rituals of several of the bundles have been lost because of the indifference of their more recent custodians. After the bundle was opened the viscera of a steer (substituted for those of a buffalo) were brought in and put down before the altar. Small pieces of meat were placed on short sticks. After the ceremonial smoking the boys ran out with these sticks, scattered over the prairie, and hid the meat offerings. The viscera mentioned above were placed outside the lodge as an offering.

All the pipes in the camp were gathered up and no one was allowed to smoke outside of the community house. These pipes were later filled and lighted by an attendant and returned to their owners.

The afternoon was devoted to a dance by the women, who held in their hands the old-fashioned hoes made of the shoulder blades of the buffalo. The dancing motion included an imitation of hoeing.

During this dance any woman whose garden is weedy may be called upon publicly to come and hoe it. On the other hand, a woman who has a well-kept garden is quickly relieved of her hoe. One of the women danced also with a scalp from the sacred bundle. The scalp was attached to a long stick and was alternately dipped in the dust and waved in the air. Women and children wearing skins of buffalo and of calves circled around the fire and were shot at with bow and arrows taken from the bundle. Sometimes an arrow was thrust between the arm and the body of an individual representing the buffalo, and when that individual, pretending to be mortally wounded, sank to earth, the person who had given the successful thrust withdrew the arrow and wiped it as though desirous of cleansing it after its imagined penetration of the flesh.

The day's ceremony, consisting of the preparation and offering of the bowl of cornmeal mush, the simulation of the act of hoeing the gardens, the offerings of meat, and the killing of buffalo in pantomime, was clearly intended to safeguard and increase the food supply. It was said that the main purpose of the ceremony was to produce favorable weather conditions for the growing corn—it should have taken place in mid-June. Secondly, war victories were recalled and names were conferred on people of all ages who wished other names.

The Arikara are related in language to the Pawnee from whom they appear to have separated several centuries ago. The religious conceptions of the two tribes are similar and in a broad way their ceremonies are alike. The American Museum possesses several of the Pawnee sacred bundles¹ and Doctor Wissler, assisted by Dr. John R. Swanton of the Bureau of American Ethnology, has taken down the rituals and investigated the ceremonies.

¹"The Sacred Bundles of the Pawnee." By Clark Wissler. *NATURAL HISTORY*. Vol. XX, Number 5, pp. 569-71.

It is fortunate that the local interest—that of the Indians and of the Historical Society of North Dakota—has resulted in an opportunity to see and make record of these ceremonies of the Arikara, which are thus made available for comparison with those of the Pawnee and those of the Hidatsa and Mandan. Im-

portant conclusions may be drawn as to the pertinacity of religious customs when the Arikara ceremonies are studied in connection with those of the Pawnee, and as to the speed and degree of assimilation when they are compared with those of recent neighbors like the Hidatsa and the Mandan.

“THE CALL OF THE MOUNTAINS”

MR. LE ROY JEFFERS is pre-eminently fitted for the writing of such a book as *The Call of the Mountains*.¹ He has felt the irresistible appeal of the high places and he has yielded to it season after season, visiting now this range and now that, gathering impressions, storing memories, imbibing the great spiritual influences that the mountains exert. It was due largely to his initiative that the bureau of Associated Mountaineering Clubs of North America was formed, with a constituency of fifty organizations interested in mountaineering, conservation, travel, and the like. In addition to being secretary of this bureau, he is librarian of the American Alpine Club and a member of several organizations having kindred purposes.

The Call of the Mountains is an inspired record of the response which Mr. Jeffers made to the summons that comes from pinnacle and cañon, from snow field and desert. But it is more; it is a chart by which others may find their way into a wonderland of entrancing sights and varied experiences. In a sense the book is a survey of the scenic riches of the United States and of parts of Canada, for so many of the sites worth visiting in North America are locked away in the mountains of that continent. The incidents of the author's thrilling climbs and descents are arranged under five

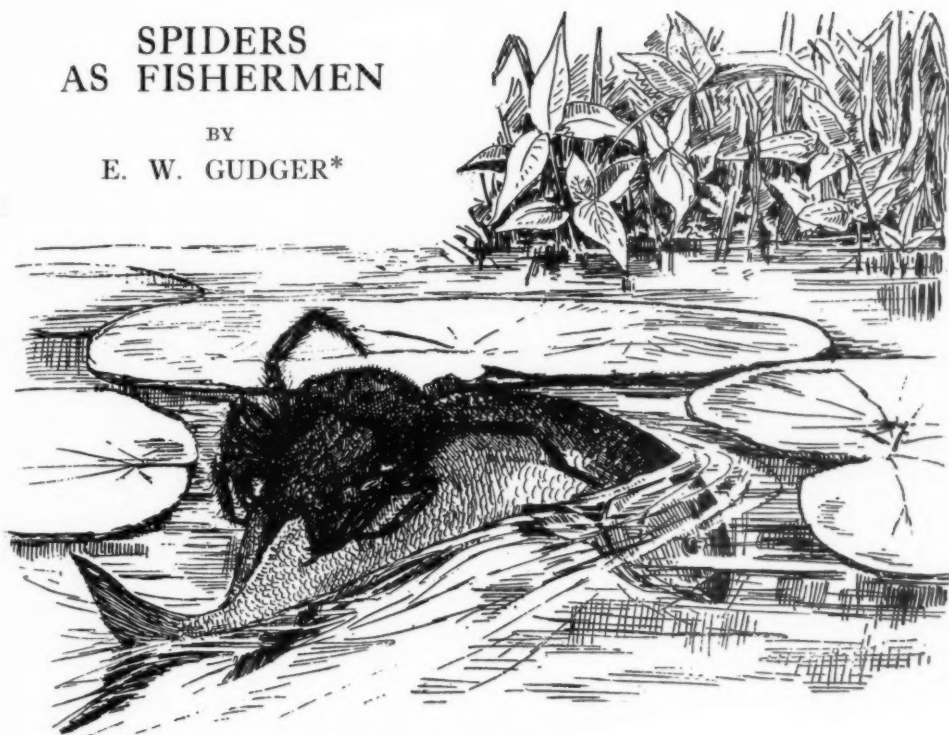
regional headings: “The Northwestern United States and Canada,” “Colorado, the Gateway of the West,” “Among the Mountains of California,” “Wonderlands of Utah and Arizona,” “Eastern Scenic Regions.” Included under these divisions is now and then a chapter which in the strict sense of the term is not a record of mountaineering and yet is by no means alien to it. The spirit of adventure that prompts a man to lower himself by hand grip down a rope attached to a tree near the edge of a cliff, in order that he may peep into a rock shelter, or that induces him to explore the interior of a cave, feeling for foot grips as he descends in partial or complete darkness, is of a character with that which sustains him on the steep and slippery climb or amid the dangers of descending avalanches. A feeling tribute to John Muir, lover of mountains, and a sketch of the fatal climb of Mount Eon by Dr. W. E. Stone and the rescue of Mrs. Stone after exposure for eight days under unusually trying conditions are fittingly introduced in the course of the narrative.

It is to be hoped that this volume, which is illustrated with superb views contributed by a number of well-known nature photographers, will lead to a better realization of the beauty and interest of our North American mountain domain and its claim to protection from spoliation.

¹Published by Dodd, Mead & Co., 1922

SPIDERS AS FISHERMEN

BY
E. W. GUDGER*



A spider, probably a *Dolomedes*, that has attacked a minnow and is retaining its hold notwithstanding the fact that the fish is twisting in the hope of ridding itself of its tormentor. The picture is reproduced from a drawing that was prepared under the supervision of Dr. Henry C. McCook, the distinguished arachnologist, from a sketch of the phenomenon made by Professor Edward T. Spring, an eyewitness of the occurrence and the first to record an encounter of this character

IT IS a fact well known to naturalists in general and to fish culturists in particular that many insects, either in the larval or the adult stage, feed on young fishes. This habit is common to some of the larval forms of the dragon flies, or darners. It is also known that the water beetle *Hydrophilus* and water bugs of the family Belostomatidae are prone to enriching their diet with young fish. Furthermore it is a matter of general knowledge that the giant bird-catching spider of South America—a representative of a class not far removed from the insects—owes its ominous name to its practice of catching small birds. But that spiders catch and presumably devour little fishes is certainly a phenomenon unknown to most of us. At any rate it would be

a hidden or relatively unknown thing were it not for the fact that in the vast literature of fishes and fishing brought together in the *Bibliography of Fishes*, of which I have been for three years associate editor with Dr. Bashford Dean, there are some references to this phenomenon. The first account led to the finding of others, and it is believed that all the known references are here brought together.

The first account is from the pen of Professor Edward T. Spring of Eagleswood, New Jersey, and dates back to 1859, nearly two thirds of a century ago. His account is the most circumstantial of those to be quoted and will be given here in full.¹

¹Spring, Edward A. [Letter regarding a fish caught by a spider]. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 1859, Vol. XI, p. 255.

"I was over on the South Amboy [New Jersey] shore with a friend, walking in a swampy wood, where a dyke was made, some three feet wide, when we discovered in the middle of this ditch a large black spider making very queer motions for a spider, and on examination it proved that he had *caught a fish*.

"He was biting the fish, just on the forward side of the dorsal fin with a deadly gripe, and the poor fish was swimming round and round slowly, or twisting its body as if in pain. The head of its black enemy was sometimes almost pulled under water, but never entirely, for the fish did not seem to have enough strength, but moved its fins as if exhausted, and often rested. At last it swam under a floating leaf at the shore, and appeared to be trying, by going under that, to scrape off the spider, but without effect. They then got close to the bank, when suddenly the long black legs of the spider came up out of the water where they had possibly been embracing the fish, reached out behind and fastened upon the irregularities of the side of the ditch. The spider then commenced tugging to get his prize up the bank. My friend stayed to watch them while I went to the nearest house for a wide-mouthed bottle. During the six or eight minutes that I was away, the spider had drawn the fish entirely out of the water, when they had both fallen in again, the bank being nearly perpendicular. There had been a great struggle—and now on my return, the fish was already hoisted head first more than half his length out on the land. The fish was very much exhausted, hardly making any movement, and the spider had evidently gained the victory, and was slowly and steadily tugging him up. He had not once quitted his hold during the quarter to half an hour that we had watched them. He held, with his head toward the fish's tail, and pulled him up at an angle of 45° by stepping backwards. How long they had been there or how far they had come we cannot tell. We saw no web anywhere about.

"The time would not permit a longer stay, so we reluctantly bottled the pair. I thought I had missed dipping up the spider, and looked along the bank, but

on turning to the bottle he was there. The fish was swimming weakly at the bottom of the water that I had dipped in, and the spider standing sentinel over him on the surface, turning when he turned, and watching every motion. We stopped the mouth of the bottle so that the spider could not escape, and went to see the fine place of the late Mr. Stevens above on the hill. Returning in about three hours, we found, to our disappointment, the spider dead at the bottom, but the fish was alive. He lived for twenty-four hours. The spider was $\frac{3}{4}$ of an inch long, and weighed 14 grains; the fish was $3\frac{1}{4}$ inches long and weighed 66 grains."

The next recital is by Mr. T. M. Peters¹ of Alabama. It was communicated to the Smithsonian Institution and by it forwarded to *The American Naturalist* in which it was published in 1876. Mr. Peters says:

"Just before the late war I was at Col. Oakley Bynum's spring, in Lawrence County, Ala., near the town of Courtland where I saw a school of minnows playing in the sunshine near the edge of the water. All at once a spider as large as the end of my finger dropped down among them from a tree hanging over the spring. The spider seized one of the minnows near the head. The fish thus seized was about three inches long. As soon as it was seized by its captor it swam round swiftly in the water, and frequently dived to the bottom, yet the spider held on to it. Finally it came to the top, turned upon its back and died. It seemed to have been bitten or wounded on the back of the neck near where the head joins. When the fish was dead the spider moved off with it to the shore. The limb of the tree from which the spider must have fallen was between ten and fifteen feet above the water. Its success shows that it had the judgment of a practical engineer."

In 1885, Dr. Henry C. McCook met Professor Spring at Chatauqua, New York, and had from him by word of

¹Peters, T. M. "A Spider Fisherman." *The American Naturalist*, 1876, Vol. X, p. 688.

mouth a detailed account of the observations first quoted. Professor Spring also drew for Doctor McCook a sketch of the attack of the spider on the minnow. In his *American Spiders and Their Spinning Work*, published in 1889, this distinguished arachnologist, after discussing the general untrustworthiness of the commonly printed and circulated accounts of the attacks by spiders on such small vertebrate animals as birds, rats, snakes, etc., reprints Professor Spring's account *in extenso*, on pp. 235-36 of Volume I of his work, giving it his full credence. Furthermore, he had Professor Spring's sketch worked up by an artist and reproduced it in connection with the account. Doctor McCook thought that the spider in question was a *Lycosa*, a wolf-spider, or more probably a *Dolomedes*. In this sketch, which is reproduced at the head of this article, the spider and the fish seem rather large in comparison with the size of the near-by lily pads.

Doctor McCook's rendition of Professor Spring's most interesting observation, is referred to on page 603 of Prof. J. H. Comstock's *Spider Book* published in New York in 1912. Professor Comstock agrees that the spider was probably a *Dolomedes*.

In the third volume of Doctor McCook's monumental work, on p. 66, is a corroboratory account of the above incident. This account seems to have escaped the attention of most students. Doctor McCook says:

"The case [above cited] has excited much interest, and it is gratifying to have it supported by a like well authenticated instance. Mr. Francis R. Welsh, of Philadelphia, writes me that a spider once killed two sun-fish, each about two inches long, that he had in a basin in his room. After having attacked the first fish it ran over the water and fastened upon the second, which was also at the time apparently well and vigorous. Mr. Welsh drove the spider off, but the fishes died in a few hours."

The next account to be given comes from nearer home. Mr. William T. Davis¹ of Staten Island, an enthusiastic member of the New York Entomological Society, writes that with some friends he was on May 10, 1890.

" . . . rambling among the innumerable little hills near Grasmere Station, on Staten Island, and in the late afternoon came to a small, wood-shaded pond. Several moderately large spiders were on its surface, a few feet from the shore, and it so happened that while I was watching one of them, in particular, that rested quietly, it suddenly made a rapid motion and seized a little silvery fish over an inch in length. It held it firmly and remained as stationary as it had been before the capture. A number of water-beetles (*Gyrinidae*) now came swimming about the spider, no doubt being anxious to share in the feast, but they quickly decamped upon the approach of the water-net that captured the Arachnid."

Mr. Davis positively identified the spider as a *Dolomedes*, and I understand, has at the present writing both spider and fish in his collection.

The next observation was made by Dr. Thomas Barbour,² of the Museum of Comparative Zoölogy, Cambridge, Massachusetts, in southern Florida in the spring of 1921. He was fishing in the upper St. Johns River in a very swampy region when the following incident occurred:

"The vegetation swarmed with *Dolomedes*, but then these spiders always seem to have a predilection for creeping about on the floating lettuce, especially. The water, both beneath the plants and in the little open spaces between them, teemed with several species of cyprinodont fishes, of which a *Gambusia*, beyond doubt affinis, was the most abundant. . . . A tiny flash of silver caught my eye, and I looked again, to see a spider carrying a small dead fish, perhaps an

¹Davis, William T. "A Spider Fisherman." *Entomological News*, 1891, Vol. II, p. 77.

²Barbour, Thomas, "Spiders Feeding on Small Cyprinodonts." *Psyche*, 1921, Vol. XXVIII, pp. 131-32.

inch long, across a wide leaf to the dark interior of a large lettuce cluster. I thought that probably the spider had found a dead fish by chance and I relit my pipe, when about six feet away in another direction the episode was repeated. This time the little fish was still struggling feebly in the spider's chelicerae. Later I saw a third fish being carried off which was dead and quite dry."

The account now to be given does not refer to the catching of a fish but of a frog in the tadpole or fish stage; however, it is so pertinent and so interesting that it is quoted herein. It is by the well-known Argentine naturalist, Carlos Berg.¹ He identifies the spider as *Diapontia kochii*, one of the Lycosidae, a vagrant given to living in certain definite localities at certain seasons of the year. His observations on this remarkable habit were made on two female specimens. He says of *Diapontia*:

"In spring it lingers on the shores of small streams and ditches, where it makes its home. This consists for the most part of a more or less horizontal hole or cavity, lined with a comparatively firm silken tissue which projects out in the shape of a funnel. Not only does it catch its prey of passing insects and spiders from the door of its cavity, but also goes out in order to search about, and, what seems most surprising, to fish. The object of its fishing is for no less than tadpoles, those swift and slippery larval frogs. But the spider knows how to set up its apparatus and how to take its precautionary measures, in order that the

toothsome morsel may not escape her. On the surface of the water, usually upon or between stones, where the tadpoles are wont to sun themselves, the spider constructs a two-winged or funnel-shaped net, a portion of which dips into the water, particularly after a rainfall, which swells the waters of the brook. The tadpoles, without suspecting the cunning of the spider, venture into the net-like wing of the tissue or its funnel, and the spider skimming from behind upon the water drives them on and finally overcomes one that has ventured deeper into the net. The shrivelled-up tadpole-skins surrounding the net convinced me of the skillfulness of the spider as a fisherman."

Although more than one of the observers above cited convey the impression that the spider devours its strange prey, one eminent authority at least, Professor Alexander Petrunkevitch, of Yale University, raises question, in a letter addressed to the present writer, whether the fish captured serves as food:

"May I add that I am a little in doubt of the possibility of spiders using fish as food for the reason that spiders predigest their food by injecting the secretion of the maxillary glands into the wound inflicted by the fangs. This fact has been demonstrated by various observers and is beyond any doubt, at least in the case of spiders feeding on insects. It has been suggested that Tarantulae may at times feed on small birds but even that is considered to be doubtful. This does not mean that a spider cannot kill a bird or a mouse or a fish, as it has been observed on various occasions, but it is not likely that any vertebrate is ever used by spiders as food."

¹Berg, C. "Eine fischende Spinne." *Kosmos, Zeitsch. f. Entwicklungslehre u. einheitliche Weltanschauung*, Stuttgart, 1883, XIII Bd., p. 375.

NOTES

ASIA

THE FAUNTHORPE INDIAN EXPEDITION OF 1923—An important expedition, headed by Col. J. C. Faunthorpe, an A. D. C. to King George and a resident commissioner in Lucknow, India, and Mr. Arthur S. Vernay of New York and London, will devote six or seven months to securing rare and representative animals in different parts of India, with a view to establishing in the American Museum a collection from that part of the world that may be commensurate with the importance and interest of its fauna. The expedition, which is made possible through the generosity of Mr. Vernay, will include a native bird collector, a taxidermist (Mr. John Jonas), a moving-picture operator, equipped with an Akeley camera and 25,000 feet of film, and native helpers to the number of thirty or more.

Mr. Vernay, who is at present in London, will sail shortly for Bombay and will be joined by Colonel Faunthorpe in Lucknow. They will proceed at once to the northern part of Nepal in the foothills of the Himalayas where they hope to obtain, in addition to a group of tigers in their winter coat, specimens of the great one-horned rhinoceros and of the sloth bear.

A tiger hunt in this region is full of picturesque interest. Natives are sent out at about six o'clock in the morning to ascertain whether there are any fresh traces of tiger. They return with their reports and if these reports are favorable, the party sets out. The gunners, of whom there are four, are mounted on elephants and, in addition, many other elephants are used as beaters and also to allay the suspicion of the tiger, accustomed as that animal is to the presence of the huge pachyderms. The herd proceeds through the thick jungle grass. At intervals the elephants trumpet and strike their trunks on the ground, while the hunters sit silent and vigilant, waiting for the moment when the tiger shall appear, probably not more than fifty yards from the beat. As the tiger rushes out, the gunner in whose direction it is leaping shoots, while the others hold their fire. Marksmanship, under such circumstances, is not easy, for the restlessness of the elephant interferes with the steadiness of the aim, and the tiger with a challenging "whoof" covers the ground swiftly with great bounds. When the animal has been laid low by a well-directed shot and has been skinned, the sharp-eyed vultures gather and in an incredibly short time devour the carcass.

In the thick grass that conceals the tiger lives also the pink-headed duck, another desideratum of the expedition, and to drive it out of its cover reliance will have to be placed on the beating elephants.

From the foothills of the Himalayas the expe-

dition will move southward to collect from one area specimens of the swamp deer, and from another black buck, sambar, and chikara.

The gaur or Indian bison—not to be confused with the Indian buffalo, of which specimens will also be collected—is the principal objective of the hunt in the district of Mysore. This spectacular animal attains a height of about six feet at the shoulders. Unlike the buffalo, it has never been domesticated, bred, or kept in captivity. It is hoped that, with the consent of the Maharajah of Mysore, an Indian bull elephant and a cow elephant may be secured in this district.

The Gir Junagarh Forest, north of Bombay, is the only region in India where the lion is found, and it is there that, subject to the approval of the Viceroy, the expedition will hunt the king of beasts.

Although the animals mentioned are particularly desired and will be the special object of search, the expedition will endeavor to secure specimens also of the cheetah, the kakar or barking deer, the wild boar, wolves, jackals, wild dogs, monkeys, civet cats, hyenas, as well as the smaller mammals, birds, and reptiles. No efforts will be spared to obtain a representative collection of animals, which arranged in habitat groups and placed in the prospective Asiatic wing of the American Museum will enable visitors to get an impression of the diversity and interest of the fauna of India.

DISCOVERIES IN MONGOLIA.—The Third Asiatic Expedition reports extraordinary success from its summer's explorations in Mongolia. Mr. Walter Granger, palæontologist of the expedition, has secured complete skeletons of small Cretaceous dinosaurs, a skull of the giant hornless rhinoceros *Baluchitherium*, and numerous other important specimens. The *Baluchitherium* skull is nearly five feet long and the animal equaled or exceeded the largest mammoths and elephants in size. A series of important fossil-bearing formations of Cretaceous and Tertiary age has been found, with very extensive exposures, which may take years to explore. This "opens up a new field in vertebrate palæontology," as Mr. Granger justly remarks, for no fossil vertebrate remains other than part of a rhinoceros jaw had previously been known from Mongolia, and except for some rather fragmentary specimens from India, dinosaurs had never been discovered anywhere in Asia.

The especial importance of a knowledge of the geological history of the animals of Central Asia has been pointed out by Prof. Henry Fairfield Osborn in an article in the September number of *Asia*, and is further discussed by Dr. W. D. Matthew in a forthcoming number of the same magazine. The great continent of Asia north of the Himalayas is, as the map shows,

the central portion of the land areas of our globe. This region, hitherto a blank page in our records, now bids fair to provide us with a great series of extinct faunas, which will throw light upon the sources of the various races of land animals that have successively invaded the outlying continents. Ultimately we hope that it may disclose important evidence bearing upon the ancestry of man, the most interesting of all the problems with which the palaeontologist has to deal but, owing to the scanty evidence, one of the most obscure and difficult. No new discoveries directly bearing upon this problem have as yet been reported by the Third Asiatic Expedition, but the extensive fossil fields discovered hold out bright prospects for further exploration.

ANTHROPOLOGY

OBJECTS RECOVERED NEAR TALTAL.—The American Museum has recently acquired from Mr. P. L. Tommen a collection of about 1700 objects that Mr. Tommen, with the aid of another man, dug from sand mounds near Taltal in the rainless area along the coast of Chile. The objects represent four different culture levels. Not far below the surface but at varying depths, owing to the shifting of the wind-blown sands, the first level was encountered, from which were unearthed objects belonging to a people later than the Inca; further digging revealed an Inca level, and below this yet another level representing pre-Inca culture. Finally the lowest level, and the one of greatest interest, was reached, where only implements of stone were found associated with the interred mummies. These mummies were lying extended at full length, differing markedly in this respect from the mummies of the three upper levels, which were placed in a sitting position with knees raised to the level of the chin. Mr. Tommen states that the mummies of this Palæolithic level are all of the dolichocephalic type; his excavations thus furnish additional support to the generally accepted opinion that the earliest inhabitants of the coasts of Peru, Chile, and Brazil, were long-headed people who had no knowledge of metals and used only very crude implements of stone, bone, and shell.

DR. P. E. GODDARD'S TRIP TO THE NORTHWEST COAST.—During the years 1897-1903 the Jesup North Pacific Expedition, financed by President Morris K. Jesup and directed by Professor Franz Boas, did systematic research on the Northwest Coast of America and the Northeast Coast of Asia. Large collections were secured for the American Museum by the expedition, which were added to those made previously by Lieut. George T. Emmons, Mr. Heber R. Bishop, and others. The American

specimens are arranged in the Jesup North Pacific hall, the care of which through successive staff changes has devolved upon Dr. P. E. Goddard. In order to give more efficient care to the hall and its labels, and more particularly in order to prepare a handbook of the Northwest Coast tribes, Doctor Goddard visited the coast of British Columbia and Alaska last summer. The first part of the trip was made in the company of Dr. C. F. Newcombe, long recognized as an authority upon the tribes of that region. At Sitka among the Tlingit he had the assistance of Lieut. George T. Emmons, who has been engaged in researches regarding this people for many years. In several of the Indian villages visited, especially at Alert Bay and Sitka, native life was seen in progress. About 1500 feet of moving picture film showing industries and handicrafts were secured. Negotiations are now under way for the purchase of carved posts as additions to the Northwest Coast hall of the American Museum.

A GIFT OF A SCARF.—The American Museum is the recipient of many gifts of specimens from those who wish in that way to evidence their faith in the purposes to which the Museum is dedicated. At times these gifts are handed over by the donors under circumstances which enable one to gauge the extent to which the Museum's exhibits have captivated the interest of those who have strayed within its halls. As an instance, there recently entered the office of the curator of anthropology a Greek bearing a scarf which he said he wished to present to the institution. The scarf had been brought from the Kurd district of Turkey by the donor's brother, who had been impressed into the Turkish army but subsequently had been released. The Greek in handing over the scarf said that through this gift he wished to show his appreciation of the exhibits which he had enjoyed on previous visits to the Museum.

AMPHIBIANS AND REPTILES

THE HEILPRIN EXPEDITION TO SANTO DOMINGO.—Doctor and Mrs. G. Kingsley Noble, of the American Museum, who set sail in July for the island of Santo Domingo, have just returned to New York. Their purpose in visiting the island was primarily to secure materials toward the construction of two groups for the new hall of reptiles.

The fauna of Santo Domingo is unique. Not only the largest tree frog in the world, but also the heaviest (if not the longest) lizard in the Americas, live on that island. Doctor and Mrs. Noble have brought back with them a large series of specimens of these two creatures, hitherto extremely rare in collections, and accessory material to be used in the reproduction

of their habitats; they also were fortunate enough to work out the life histories of both animals, about which little or nothing was previously known.

The expedition was made possible through friends of the Museum, and was called the Angelo Heilprin Expedition to the Dominican Republic. Thanks to the coöperation of the Marine Corps and the Guardia Nacional Dominicana, the expedition crossed the entire length of Santo Domingo in a very short time and was able to investigate fully localities which have never before been visited by naturalists.

The expedition went prepared to make permanent record of the behavior of the animals encountered, and one of the outstanding results is the collection of flashlight portraits of tropical frogs. By the aid of extra-fast flash powder, frogs have been snapped while in the act of singing, caring for their eggs, and making their way through the jungle, wholly unaware that they were being observed.

The life histories of practically all of the Amphibia of Santo Domingo were investigated, and the eggs and young of a large proportion of the species secured. Several new types of breeding behavior were observed. It was found that the giant tree frog lays its eggs among stones near the mountain torrents, and the tadpoles which hatch out are adapted to life in the rushing current. They are equipped with an adhesive apparatus which enables them to hold on to boulders in mid-stream. The expedition furthermore ascertained that the giant tree frog, in spite of its great adhesive toes, was not entirely arboreal in its habits, but was very fond of resting for hours on moss-covered boulders near the mountain torrents, where the atmosphere and vegetation were saturated by the mists which arose from the falls.

The rhinoceros iguana is restricted to the arid southwestern portions of Santo Domingo. Along the edge of Lake Enriquillo, a salt lake more than 130 feet below sea level, this great saurian was found fairly abundant. It digs burrows in the banks of dry ravines and sallies forth only during the heat of the day. The expedition secured alive more than fifty iguanas. These were captured by means of dogs. The biggest iguanas, however, would often break through even the largest pack of dogs employed and in such cases it was found necessary to shoot them and prepare their skins in the field. The expedition was very fortunate in finding the eggs of the iguana just at the time they were hatching. These were laid in sandy pockets, generally more than a foot below the surface. The eggs are white, about the size of a hen's egg, but with a soft shell. The iguanas which hatch out sometimes carry their shells with them to the surface, and it was through the finding of these empty shells that the breeding sites of the iguanas were first discovered.

VERTEBRATE FOSSILS

RECONNOISSANCE AND COLLECTING IN NEBRASKA.—The Nebraska Field Expedition of the American Museum, in charge of Mr. Albert Thomson, spent the season of 1922 collecting in the Snake Creek and Agate quarries in western Nebraska. Dr. W. D. Matthew joined the expedition for a part of the season and with Mr. Childs Frick made a general reconnaissance of the formations to the north and south of the quarries as far as Pawnee Buttes, Colorado. A careful study of the stratigraphy and fossils of the Snake Creek quarries shows that three distinct geological horizons are represented, from each of which large collections of fossil mammals have been secured. The collection made this year is chiefly from the oldest of the three horizons, from which comparatively little material had hitherto been obtained. It includes a few good skulls, several hundred upper and lower jaws, and innumerable teeth and bones, chiefly of three-toed horses, but including also camels, deer antelopes, various Carnivora, and rodents. Many of the species are new or little known, and the comparison of this fauna with the two that succeeded it at this locality will enable us to trace a number of races of mammals through these three successive stages in their evolution, with the aid of a very large amount of material to show the range of variation at each stage in their progress. Such abundant evidence enables the student of evolution to draw sound and definite conclusions as to the true history of the evolutionary changes in the several races of animals the record of which is thus inscribed in the rocks.

BIRDS

BIRDS OF THE AZORES AND CAPE VERDE ISLANDS.—The department of ornithology of the American Museum has recently profited through field work conducted in the Azores and the Cape Verde Islands by Mr. José G. Correia, of New Bedford, Massachusetts. Mr. Correia, who is a native of Fayal, in the Azores, accompanied Dr. Robert Cushman Murphy on the South Georgia expedition of 1912 and 1913. He was at that time a member of the crew of the whaling brig "Daisy." Because of his innate interest in natural history he developed into a competent collector, and during the years since that time he has made several voyages in the interests of ornithological science.

The material which has been received from the Azores and Cape Verde Islands comprises several hundred specimens, and is particularly rich in marine birds. One species of gull has proved to be a new geographical race, and has recently been described in the *American Museum*

Novitates by Dr. Jonathan Dwight as *Larus fuscus atlantis*. It is apparently the resident form at the eastern Atlantic islands of a widely distributed northern gull. Among the other birds are no less than five species of petrels, as well as splendid series of boobies, tropic birds, and some of the rare insular species of land birds.

To accompany his collection of specimens, Mr. Correia has prepared an interesting account in Portuguese regarding the life histories of the birds and concerning the islands which he visited. This information will of course add very materially to the value of the published results.

LECTURE BY DR. R. C. MURPHY.—At the intermonthly meeting of the Geographic Society of Chicago, held on Friday, October 27, Dr. Robert Cushman Murphy, associate curator of marine birds, American Museum, delivered a lecture on "The Way of the Sperm Whaler," in which he drew upon his experiences in hunting the whale with harpoon, hand lance, and other tackle during a sixteen-thousand-mile voyage in the brig "Daisy."

FIRE PREVENTION WEEK

ASBESTUS EXHIBIT.—Fire Prevention Week, October 2-9, was signalized at the American Museum by the installation of an exhibit of asbestos and articles showing some of the uses to which this important fire-resisting material is applied. The asbestos of commerce is the chrysotile of the mineralogist and is a delicately fibrous form of serpentine. It occurs in veins in massive serpentine in the Archaean rocks of the Province of Quebec and the state of Arizona, where it is extensively mined or quarried for technical purposes. It is not confined, however, to these localities. The mineral of long uniform fiber is carded, spun, and woven into cloth, which is used for the making of theater fire-curtains, clothing, mittens, etc. The mineral of shorter fiber is likewise separated into its component threads and used in the making of fire-proof boards and shingles and other roofing materials, as well as for an insulating covering for boilers, steam pipes, and the like. The material forming the exhibit was very kindly lent and installed by the Johns-Manville Company.

THE CENTENARY OF LOUIS PASTEUR

December 27, 1922, will mark the one hundredth anniversary of the birth of Louis Pasteur, founder of the science of bacteriology, at Dôle, Department of Jura, France. Pasteur was graduated in 1847 from the École normale in Paris, as a chemist and mineralogist, and early in 1849 became professor of chemistry in the University of Strassburg. His eminent work

led to his election in 1862, at the age of forty, as a member of the section of mineralogy in the Académie des Sciences. His great work for the deliverance of man from plague and pestilence was accomplished in the period following this appointment to the time of his death in 1895.

The members of the New York Mineralogical Club felt that so historical an event as the centenary of Pasteur's birth should be fittingly celebrated in New York. Accordingly at the meeting of the club last May President George F. Kunz was empowered to arrange the details. As a fruition of this plan the auditorium of the American Museum will be the scene of a great meeting on the evening of December 27, which will be held in coöperation with specialists in the lines in which Pasteur made his greatest discoveries. The Hon. Henry Cantwell Wallace, Secretary of Agriculture, has expressed his willingness to attend, unless prevented by affairs of state, and the newly elected senator from New York State, Dr. Royal S. Copeland, has also signified his intention to be present.

In addition to the meeting it is proposed to hold an exhibition designed to illustrate the great contributions of Pasteur to science. It was his observations on the ferments of beers and wines which paved the way for his studies in the bacteriology of disease. Of the greatest importance to French industry was his discovery of the causes of the silkworm's disease, which threatened the silk production of that country, and his indication of a specific for its prevention, the successful use of which restored the industry to its former prosperity. Cholera in fowls next engaged his attention, followed by his investigation of anthrax in cattle. Both of these scourges were brought under control through his researches. Of even more far-reaching importance to human welfare was his discovery of the antitoxin for hydrophobia.

As part of the exhibit, will be presented illustrations of the treatment of the ferments in milk which has led to the method denominated "Pasteurization."

One of the earliest triumphs of Pasteur's investigations was the interpretation of the different behavior of two tartaric acids, one of which turned to the right the plane of a ray of polarized light, while the other remained inoperative. The inactivity of the second acid was due to the fact that it was composed of two isomeric constituents diverting the rays in opposite directions. The original model of a tartaric acid crystal, eight inches high, used in Pasteur's class lectures, and bearing a label in his own handwriting, will be shown. This model, together with a remarkable glass case containing objects of equal interest relating to Curie, Lister, and others, was presented to the Medical Museum of the University of Pennsylvania by Dr. Robert Abbe of New York.

The centennial will be independently cele-

brated by the New York Academy of Medicine, of which Dr. Charles L. Dana is president, on December 27, and there will be a memorial meeting on January 10, 1923.

A festival in honor of the Pasteur centenary will take place in Strassburg under the auspices of the University where he occupied the chair of chemistry. On June 1, 1923, a monument to his honor will be unveiled at the Place de l'Université. Another phase of the festival will be the creation of the Museum of Hygiene designed to commemorate his discoveries, and to illustrate the development of the science of bacteriology. A special exhibition, designated as that of the Pasteur Centenary, is to show objectively all the consequences of his work in the departments of medicine, of hygiene, of industry, and of agriculture. This exhibition will be inaugurated on June 1, 1923, by President Millerand of the French Republic, assisted by members of the Ministry and of the Parliament, as well as by numerous scientists of France and of other nations.

A beautiful acknowledgment of Pasteur's worth and moral greatness is given by Professor Henry Fairfield Osborn in his little book *The New Order of Sainthood*.¹ He queries whether we ought not to found a new order of Sainthood for men like Pasteur, and asks whether a statue of Louis Pasteur in the Cathedral of St. John the Divine would not proclaim the faith of the modern church that the two great historic movements of love and knowledge are harmonious parts of a great and eternal truth.

ENOS A. MILLS

Enos A. Mills, who died on September 21, at Longs Peak Inn in the Rocky Mountains National Park, was born in the plains region of the Middle West, but it is with the wonderland of the Rockies, with the frost-scarred peaks of his beloved Colorado, that his memory will be enduringly associated. Long before the Government took steps to establish as a national park the region to which Estes Park is the portal, Mills had fallen under the spell of its attraction. His lone cabin, erected in 1886 at the foot of Longs Peak—the majestic mountain that dominates the Park from its altitude of more than 14,000 feet—in time gave place to the commodious Longs Peak Inn with its assemblage of cottages, a veritable Mecca for nature lovers from all parts of the country, who found inspiration not only through the more intimate contact with nature afforded by the isolated locality but also in the personality of the man who presided over the Inn and who, through his writings and his addresses, had the faculty of

kindling in others the enthusiasms which he felt so genuinely.

In one of his volumes he speaks of the wilderness as "the safety zone of the world," and though many of his adventures were spiced with danger and might easily have terminated unhappily in the case of a less experienced mountaineer, he was throughout master of his environment. Yet he who had raced on skis down the slippery, tree-encumbered mountain-side, pursued by a descending avalanche bent on engulfing him; who had made friends with beasts like the grizzly that most of us stand in awe of even as we gather in front of the iron bars that form its prison enclosure; who had been snow-blinded when alone on the summit of the Continental Divide and forced to feel his way with his staff, in peril of stepping off a cliff or walking overboard into a cañon—succumbed ultimately to injuries sustained in a Subway accident during a visit to New York.

Enos Mills preached the gospel of the love of natural things and exemplified his teachings in his life. He pleaded for the protection of wild animals—even those which we regard with a fear that is genuine but immoderate. He knew from his intimate contact with nature and the fellowship it engenders that a dead trophy is not comparable in inspirational value with the memory of a close-up observation of a living animal that has lost its fear of man.

NEWS FROM KARTABO

The amazing diversity of animal life in certain regions where man and his innovations have not challenged the dominion of nature is well illustrated by the results which Mr. William Beebe, director of the Tropical Research Station of the New York Zoological Society, has obtained. Working intensively over a "quarter mile of jungle and shore," Mr. Beebe has secured within this little patch no less than 717 species of vertebrates. Among his recent acquisitions one of the most interesting is a giant armadillo, which is to be sent to the American Museum. Not only were anatomical notes regarding this creature made at Kartabo, but a colored plate of it was prepared by Miss Isabel Cooper, the artist attached to the Station, whose paintings of tropical animals are records as valuable in their way as the specimens themselves.

Real excitement attended the capture of a great anteater, which took possession of Mr. Beebe's boat and forced the rightful occupants into the water. Motion pictures of this spirited incident were fortunately secured and will serve as a record of the formidable vigor of this animal, which is to be shipped to the New York Zoological Park.

¹*The New Order of Sainthood*, by Henry Fairfield Osborn, New York, MCMXIII. 8vo., 17 pp.

PAN-PACIFIC SCIENTIFIC CONFERENCE

THE Pacific Ocean covers a surface of 55,000,000 square miles, the equivalent of the entire land area of the globe, and the countries that border it and the islands that are scattered over its vast expanse present a diversity of problems that can be solved only through the cooperative effort of many trained minds. It was "to outline scientific problems of the Pacific Ocean region and to suggest methods for their solution; to make a critical inventory of existing knowledge, and to devise plans for future studies" that the First Pan-Pacific Scientific Conference was held at Honolulu, Hawaii, from August 2-20, 1920, presided over and directed by Dr. Herbert E. Gregory, Silliman professor of geology at Yale University. The papers presented, grouped according to subject matter, with stenographic reports of the discussions that they evoked have been published in three volumes, wherein are also contained the list of committees, the calendar of proceedings of the general sessions and of the sections, an alphabetic list of the delegates attending, and the resolutions adopted.

No one glancing over these volumes can fail to be impressed by the magnitude of this seemingly diverse yet fundamentally interrelated subject matter where the aid of sister sciences must be called upon to solve the special problems confronting each. Dr. Clark Wissler, curator of the department of anthropology, American Museum, who, as leader of the section of anthropology, spoke on "Man in the Pacific," pointed out the service that might be rendered anthropology by data regarding the geological chronology, the fauna, and the flora of the region. "You tell us," said he, "the history (a relative chronology) of such plants as taro, breadfruit, and paper mulberry, etc., and the story of such animals as the pig, chicken, and dog in the islands of the Pacific, and we will soon fill in the gaps in the chronological scheme for the Polynesians."

More intensive study of the fauna and flora of the numerous islands of the Pacific is needed, too, in order to settle the problem of their one-time land connection or their primeval isolation. Are the Hawaiian Islands, for instance, oceanic in origin or continental? The evidence of entomology, as Dr. F. Muir points out in his paper, is overwhelmingly in favor of the oceanic theory, for "the most striking thing about the Hawaiian fauna is the absence of whole groups and the orders present are represented by only a few families, which could have come by flight or by air or ocean currents." On the other hand, Dr. H. A. Pilsbry, from a study of the distribution of the land snails, hazards the opinion that, as evidenced by their homogeneous fauna, the mid-Pacific islands from the Cook group to the Marquesas are the remnants of a fragmented continental mass.

It is in the region of the Pacific that have occurred several of the most cataclysmic volcanic eruptions as well as devastating earthquakes, and it is fitting that so large a space is given over to these subjects. Dr. T. A. Jaggar Jr., who contributed the interesting article on the Hawaiian Volcano Observatory to the issue of *NATURAL HISTORY* for July-August, 1921, opens the discussion of this division of the problems of the Pacific with "The Program of Experimental Volcanology." In the North Pacific, Dr. G. W. Littlehales points out, there is a tract twice as large as the United States which has been crossed by only a single line of soundings about 250 miles apart, and in other portions of this ocean there are areas as large as Australia that remain entirely unfathomed. One can readily see, therefore, that in the mapping of the Pacific a vast amount of work still remains to be done. Other interesting papers are those grouped under meteorology, ocean currents, the geological mapping of the Pacific, correlations of Post-Cretaceous formations in the Pacific region, and miscellaneous papers on geology.

FOOTBALL—AN ANCIENT GAME

FOOTBALL may at first thought seem merely the virile ideal of modern adolescent manhood, a special creation of our age. Such is, however, not the case, for though in many respects the sport has undergone specialization and even transformation in more recent times, it is in its essentials of great antiquity; indeed, games of more or less similar character were played by many primitive peoples.

An interesting theory as to the possible origin of football is discussed by E. K. Chambers in the *Medieval Stage*. According to this theory there were in ancient times scrimmages for the possession of the head of an animal that had been sacrificed. It was thought that such a head, if buried in a field, assured plenteous crops; hence it was a thing worth fighting for. Today the struggle is still waged as keenly as ever but instead of the sacrificial head, there has been substituted a football, the mystic potency of which is limited to the interest its changing fortunes evoke among the players and among the packed rows of frenzied spectators at our big games. It is worth recording in this connection, that the Eskimos about Bering Strait have a picturesque interpretation of the Northern Lights. They speak of the phenomenon as a game played by shades, in which, in place of a ball, the object of contention is the skull of a walrus.

We speak of the football as "the pigskin." In the time of Henry VIII a pig's bladder was used. The English poet, Alexander Barclay, writing in that age, contributes this spirited description:

They get the bladder and blowe it great and thin,
With many beanes or peason put within,
It ratleth, soundeth, and shineth clere and fayre,
While it is throwen and caste up in the ayre,
Eche one contendeth and hath a great delite
With foote and with hande the bladder for to
smite,

If it fall to grounde they lifte it up agayne,
This wise to labour they count it for no payne
Renning and leaping they drive away the colde.
The sturdie plowman lustie, strong and bolde
Overcommeth the winter with driving the foote
ball,

Forgetting labour and many a grevous fall.

The allusion to "many a grevous fall" is proof that there is time-honored precedent for the violence still incident to this sport. Indeed, as played in the good old days, football was a game so rough and noisy that both Henry VIII and Elizabeth enacted laws against it. Sir Thomas Elyot, writing in 1531, speaks of football as being "nothyng but beastly fury and extreme violence, whereof proceedeth hurte and consequently rancour and malice do remayne with thym that be wounded, wherefore it is to be put in perpetual silence." An even more wrathful denunciation appears in Stubbes' *Anatomy of Abuses*, written some fifty years later, wherein football is referred to as "a devylishe pastime" giving rise to "envy, rancour and malice, and sometimes brawling, murther, homicide, and great effusion of blood, as experience daily teacheth."

Among the American aborigines many different ball games were played and certain of these, in which the ball was propelled by kicking, sometimes supplemented, as among certain of the Eskimos, by whipping with a specially constructed driver, are classed by Stewart Culin in his *Games of the North American Indians* as football. Some of these games were not lacking in violence. Of the game of football played by the Micmac, a writer in *The American Anthropologist*, Vol. VIII, p. 35, relates: "In more recent times a player may catch his opponent by the neck and thus hold him back until he can obtain the ball himself, but scalping was anciently employed as a means of disposing of an opponent." This reference to scalping is no doubt based upon well-known legends in which the player forfeits his scalp to the winner. In the Cherokee ball game, a form of lacrosse, "about everything short of murder" was allowable.

Among the Topinagugim Indians of California rival teams of men and of women participated in a ball game, the rules of which permitted the women to advance the ball with their hands or in a handled basket, while the men could use only their feet to drive the ball toward the goal of their more favored opponents. Among the Crows shinny was played by men ranged against women.

To those who have known the rigors of the

training table and the restrictions there imposed, the indulgences of the Menomoni lacrosse players will seem strangely at variance with the usual rules of behavior governing athletes. "On the ground," says Mr. Walter J. Hoffman, "a cloth is spread, and on this are placed tobacco, pipes, and matches, to which all the participants are at liberty to help themselves." It has been stated that among the Choctaw, while a ball game is in progress, the women run about and give hot coffee to the players. Their ministrations are not, however, wholly benevolent. "In one hand," we are told, "they carry a cup of coffee and in the other a quirt with which they whip the players when they think they are not playing hard enough."

MEETINGS OF SCIENTIFIC SOCIETIES

THE AMERICAN ORNITHOLOGISTS' UNION held its fortieth stated meeting at the Field Museum in Chicago, October 24-6. A list of ninety-eight members whose presence was expected, representing localities scattered all over the United States, Canada, and even Europe had been printed in advance, but this number was exceeded by the actual attendance. Dr. Arthur A. Allen, professor of ornithology at Cornell University, was elected a fellow, a distinction restricted to a total of fifty individuals.

The American Museum was well represented on the program, the following papers being contributed by members of its scientific staff: "Distribution of the Genus *Momolus*," "A Possible Mutant in the Genus *Buarremon*," and "A Summer in Ecuador," by Dr. Frank M. Chapman; "The Whitney South Sea Expedition of the American Museum of Natural History" and "On a Collection of Birds from the Cape Verde Islands," by Dr. Robert Cushman Murphy; "Variations in the Structure of the Aftershaft and Their Taxonomic Value," by Mr. W. DeWitt Miller; "The Vocal Organs of the Prairie Chicken," by Mr. James P. Chapin; "The Role of the Bird Census" and "Notes on *Donacobius*," by Mr. Ludlow Griscom; "Remarks on Methods of Measuring Birds," by Mrs. E. M. B. Reichenberger; "Notes on Off-Shore Atlantic Birds," by Mr. J. T. Nichols.

AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS.—The seventh annual meeting of the American Society of Ichthyologists and Herpetologists was held at the Field Museum, Chicago, on Friday, October 27. Mr. John T. Nichols, associate curator of recent fishes, American Museum, read a paper entitled "Notes on the Tunny and Its Relatives." Dr. William K. Gregory, curator of comparative anatomy, contributed an abstract of his paper on "A Middle Jurassic Fish Fauna from West-

ern Cuba, with Remarks on the Adaptive Radiation of the Holostean Ganoid Fishes." Mr. Karl P. Schmidt, until recently connected with the department of herpetology, American Museum, and now in charge of the reptile department at the Field Museum, spoke on "The Distribution of Lower Californian Reptiles." The eighth annual meeting of the society will be held in Cambridge, Massachusetts.

SINCE the last issue of NATURAL HISTORY the following persons have been elected members of the American Museum, making the total membership 6,438.

Patron: MISS HELEN CLAY FRICK and MR. A. PERRY OSBORN.

Life Members: MESDAMES J. G. BRADY, THOMAS R. PROCTOR; MISS DOROTHY BULL; CHAS. B. J. MITTELSTAEDT, M. D.; PROFESSOR ALFRED C. KINSEY; MESSRS. PHILIP DE RONDE, PHILIP L. GOODWIN, HERMANN NORDEN, JOHN M. PHILLIPS, and HENRY H. WEHRHANE.

Sustaining Member: MR. W. RODMAN FAY.

Annual Members: MOTHER TERESA; SISTER M. CHARITA; MESDAMES SAMUEL J. BROADWELL,

HAROLD BROWN, W. R. CONKLIN, THYRZA BENSON FLAGG, A. G. GERSTER, F. NORTON GODDARD, HARRY L. HAMLIN, GEORGE FREDERICK LAIDLAW, D. McATEER, CHARLES MERGENTIME, MARTHA DOANE REID, HOWARD CROSBY WARREN; the MISSES FLORENCE BIRCH, ALICE A. DRIGGS, HARRIET KEITH FOBES, JESSIE ZIEGLER; the REVEREND DR. A. EDWIN KEIGWIN; DOCTORS ROBERT EMERY BRENNAN, CHARLES J. DILLON, ALICE GREGORY, E. H. RAYMOND, JR.; MESSRS. CALEB S. BRAGG, GEORGE T. BROKAW, J. WRIGHT BROWN, HENRY R. CAREY, CARL B. ELY, WILLIAM FAHNESTOCK, CHARLES S. FAYERWEATHER, WM. A. FRASER, HENRY M. FRIEDMAN, WALTER S. GIFFORD, ALBERT Z. GRAY, WM. H. GRUEBY, EVERETT B. HEYMAN, CHAS. T. HINDLEY, ROBERT A. JACKSON, ROBERT PORTNER KOEHLER, C. LAGEMANN, CHARLES OTIS, HENRY VAN RIPER SCHEEL, ARTHUR H. SLEIGH, HARRY D. WEST, and the POLYTECHNIC PREPARATORY SCHOOL.

Associate Members: MAJOR M. PORTAL, D. S. O.; DOCTORS JAMES CHACE, ELDRIDGE G. CUTLER; MESSRS. GEO. DENEGRE, LUTHER H. JOHNSON, LOUIS KRUMBHAAR, S. B. MONROE, TOLBERT REAVIS, JAMES D. ROBERTSON, ELMER G. SPENCER, ROSCOE J. WEBB, and the DEPARTMENT OF GEOLOGY AND GEOGRAPHY, NORTHWESTERN UNIVERSITY.

THE AMERICAN MUSEUM OF NATURAL HISTORY

FOUNDED IN 1869

MEMBERSHIP MORE THAN SIX THOUSAND

For the enrichment of its collections, for scientific research and exploration, and for publications, the American Museum of Natural History is dependent wholly upon membership fees and the generosity of friends. More than 6000 members are now enrolled who are thus supporting the work of the Museum. The various classes of membership are:

Associate Member (nonresident)*	annually	\$3
Annual Member	annually	10
Sustaining Member	annually	25
Life Member		100
Fellow		500
Patron		1,000
Associate Benefactor		10,000
Associate Founder		25,000
Benefactor.		50,000

*Persons residing fifty miles or more from New York City

Subscriptions by check and inquiries regarding membership should be addressed: George F. Baker, Jr., Treasurer, American Museum of Natural History, New York City.

NATURAL HISTORY: JOURNAL OF THE AMERICAN MUSEUM, FREE TO MEMBERS

As in the past, NATURAL HISTORY will be sent free to Members and Associate Members of the American Museum. Through NATURAL HISTORY they are kept in touch with the progress of the Museum and with the study and exploration of nature in various parts of the world.

COURSES OF POPULAR LECTURES FOR MEMBERS

In the fall and in the spring of each year a series of illustrated lectures on natural history subjects is held on alternate Thursday evenings. These lectures are open to members and to those holding complimentary tickets given them by members.

Illustrated stories for the CHILDREN OF MEMBERS are told on alternate Saturday mornings in the fall and in the spring.

MEMBERS' CLUB ROOM AND GUIDE SERVICE

A room on the third floor of the Museum, equipped with every comfort for rest, reading, and correspondence, is set apart during Museum hours for the exclusive use of members. The service of an instructor for guidance when visiting the Museum is one of the privileges of membership.

THE AMERICAN MUSEUM OF NATURAL HISTORY

ITS PURPOSES AND PUBLICATIONS

The American Museum of Natural History was founded and incorporated in 1869 for the purpose of establishing and maintaining a Museum and Library of Natural History; of encouraging and developing the study of Natural Science; of advancing the general knowledge of kindred subjects, and to that end of furnishing popular instruction.

During 1921 the Museum has been visited by no fewer than 1,174,397 individuals, all of whom have had access to its exhibition halls without the payment of any admission fee whatsoever. This figure contrasts with a total of 1,038,014 attained in 1920. The LIBRARY, comprising 100,000 volumes, is at the service of scientific workers and others interested in natural history, and an attractive reading room is provided for their accommodation. LECTURES, some exclusively for members and their friends, others for the general public, are delivered both in the Museum and at outside educational institutions. EXPEDITIONS, working in different parts of the globe, are enriching the Museum's exhibits and study collections.

The SCHOOL SERVICE of the Museum reaches annually nearly 1,500,000 boys and girls, through the opportunities it affords classes of students to visit the Museum; through lectures on natural history especially designed for pupils and delivered both in the Museum and in many school centers; through its loan collections, or "traveling museums," which during the past year circulated among 477 schools. During the same period 209,451 lantern slides were loaned by the Museum for use in the schools.

The POPULAR PUBLICATIONS of the Museum, in addition to NATURAL HISTORY, include HANDBOOKS, which deal with the subjects illustrated by the collections, and GUIDE LEAFLETS, which describe some exhibit, or series of exhibits, of special interest or importance, or the contents of some hall or some branch of Museum activity.

The SCIENTIFIC PUBLICATIONS of the Museum, based upon its explorations and the study of its collections, comprise the MEMOIRS, of quarto size, devoted to monographs requiring large or fine illustrations and exhaustive treatment; the BULLETIN, issued since 1881 in octavo form, dealing with the scientific activities of the departments, aside from anthropology; the ANTHROPOLOGICAL PAPERS, recording the work of the staff of the department of anthropology; and NOVITATES, devoted to the publication of preliminary scientific announcements, descriptions of new forms, and similar matters.

A detailed list of the publications, with prices, may be had upon application to the Librarian, American Museum of Natural History, New York City

q
al
g
ar

s,
l-
n
ic
is
rs
m
at

rs
n;
h
g
ne
s.
s-
s,
n-
y.
ns
to
ne
es
s,
s,
of

he